SERA TR 07-52-05-08a

Gleams-Driver User Guide (Version 1.8)

Submitted to:
Paul Mistretta, COR
USDA/Forest Service, Southern Region
1720 Peachtree RD, NW
Atlanta, Georgia 30309

USDA Forest Service BPA: **AG-3187-C-06-0010**
USDA Order No. **AG-43ZP-D-06-0025**
SERA Internal Task No. 52-05

Prepared by:
Patrick Durkin

Submitted by:
Syracuse Environmental Research Associates, Inc.
5100 Highbridge St., 42C
Fayetteville, New York 13066-0950

E-Mail: **SERA_INC@msn.com**
Home Page: **www.sera-inc.com**

December 31, 2007

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

NOTE: The tables followed by the figures are listed in order following Section 9 (References). Some figures or parts of some figures are also embedded in the main text. These are not numbered and are not included in the above listing.

LIST OF APPENDICES

LIST OF ATTACHMENTS *(By Reference)*

SERA (Syracuse Environmental Research Associates, Inc.). 2006a. Modifications to Gleams-Driver Version 1: Default Values for Soil Organic Matter. SERA TR-052-05-03b, dated Nov. 16, 2006. Available at: www.sera-inc.com.

SERA (Syracuse Environmental Research Associates, Inc.). 2006b. Modifications to Gleams-Driver Version 1: Augmentation of Chemical Database. SERA TR-052-05-01b, dated Aug. 5, 2006. Available at: www.sera-inc.com.

SERA (Syracuse Environmental Research Associates, Inc.). 2006c. Modifications to Gleams-Driver Version 1: Expanded Weather Files. SERA TR-052-05-04a, dated Dec. 17, 2006. Available at: www.sera-inc.com.

SERA (Syracuse Environmental Research Associates, Inc.). 2006d. Modifications to Gleams-Driver Version 1: Linking to WorksheetMaker. SERA TR-052-05-04a, dated Dec. 17, 2006. Available at: www.sera-inc.com.

NOTE: These *attachments* are not physically attached to this PDF file because most users will not need to consult them and will not be interested in doing so. All of these documents are attached by reference. All of these documents are available in PDF format at the SERA web site. To get copies of the first three, click on the **Gleams-Driver** tab at the SERA site. To get a copy of the fourth attachment, click on the **FS Methods/Tools** tab at the SERA site.

CONTRIBUTORS

This document and the Gleams-Driver program was prepared by Syracuse Environmental Research Associates, Inc. (SERA Inc.) under USDA Forest Service Contract: AG-3187-C-06-0010, USDA Order No. AG-43ZP-D-06-0025.(Dr. Paul Mistretta, COR). The concept for Gleams-Driver was developed by Drs. Paul Mistretta (USDA/FS) and Patrick Durkin (SERA) over the course of several years based on internal software developed by SERA Inc. as well as suggestions and discussions with various USDA employees, particularly Dr. Linda Abbott (USDA/ORACBA). Gleams-Driver was coded by Patrick Durkin with the technical assistance and review of Dr. Walter Knisel (USDA/ARS, retired).

1. INTRODUCTION

GLEAMS (**G**roundwater **L**oading **E**ffects of **A**gricultural **M**anagement **S**ystems) is a root zone model that can be used to examine the fate of chemicals in various types of soils under different meteorological and hydrogeological conditions. GLEAMS was developed by the USDA (Knisel et al. 1992; Knisel and Davis 2000) and is maintained by the USDA Agricultural Research Service (ARS), Southeast Watershed Research Laboratory, in Tifton Georgia (http://www.ars.usda.gov/ main/site_main.htm?modecode=66-02-05-00). The ***Gleams-Driver*** program is a pre-processor and post-processor for GLEAMS. It prepares input files for GLEAMS, runs the GLEAMS program, and then reads and processes the output from GLEAMS.

The GLEAMS program itself is not difficult to use for individuals who are comfortable with DOS-based programs. GLEAMS comes with DOS-based input file editors to facilitate use. GLEAMS output files provide direct estimates of concentrations and/or amounts of pesticides in and losses of pesticides from treated fields. This output may then be used to estimate concentrations of pesticides in either nontarget fields or bodies of water. This process, however, can be time consuming and somewhat intimidating for individuals who are not comfortable with DOS programs. Many individuals in the Forest Service have expressed an interest in having the capability to run GLEAMS in an environment that will handle the pre-processing (i.e., preparation of input files) as well as post-processing (i.e., the use of output files to estimate concentrations in offsite areas such as fields, streams, and ponds). In response to this need, Region 8 of the USDA/Forest Service commissioned the development of the Gleams-Driver program.

GLEAMS has been used as a modeling tool in Forest Service risk assessments over the past 8 years (SERA 1999). Initially, GLEAMS simulations conducted for Forest Service risk assessments were based on GLEAMS Version 2 (Knisel et al. 1992). The results from GLEAMS 2 were used to estimate concentrations of pesticides in soil. In addition, auxiliary programs were developed by Syracuse Environmental Research Associates (SERA) using Visual dBase (Version 5.7, 16-bit) to provide estimates of pesticide concentrations in water using relatively simple models for ponds (fixed volume) and streams (fixed flow) (SERA 2000). With the release of GLEAMS Version 3 (Knisel and Davis 2000), the auxiliary programs developed by SERA were ported from Visual dBase to dBASE PLUS (Version 2.01, 32-bit http://www.dbase.com/) and revised to improve performance. In addition, the water models were revised to include variable water volumes for ponds and variable flow volumes for streams (SERA 2004).

The previous auxiliary programs developed by SERA (2000, 2004) were developed internally by SERA and were intended only for in-house use in the support of the preparation of Forest Service risk assessments. While key algorithms in the source code were included in the SERA (2000, 2004) documentation and full source code was provided with various risk assessments, this source code was of little use to individuals who were not familiar with XBASE languages such as Visual dBase and dBASE PLUS. In addition, the source code was not intended for

general use and distribution and substantial modifications to the source code to permit site-specific exposure assessments were time consuming and error prone.

An additional limitation of the previous programs used by SERA involved the generic nature of the exposure assessments that are used in Forest Service risk assessments. As detailed in SERA (2004), it is impossible to anticipate the range of exposures that might be encountered in the forestry applications of pesticides. As an alternative, the generic exposure assessments included in Forest Service risk assessments attempt to encompass an extreme range of conditions by modeling applications to sand, loam, and clay at annual rainfall rates ranging from 5 inches to 250 inches. During the first year of the simulations prior to pesticide applications, rainfall was assumed to occur in a uniform amount each day. In all subsequent years, the rainfall was modeled to occur in uniform amounts once every tenth day.

There is no expectation that this set of exposure assumptions will realistically reflect natural rainfall patterns. In combination with other extreme assumptions concerning site-characteristics, the intent of the generic modeling in Forest Service risk assessments is to develop extreme values for exposure assessments that are likely to encompass levels of exposure that might be realized in Forest Service programs. As a result, modeled concentrations of pesticides in water and soil often varied by factors of well over 1000 in many of the Forest Service risk assessments. These estimates, however, are difficult to adapt to site-specific environmental assessments, environmental impact statements, and other related activities that are routinely conducted by Forest Service personnel.

The development of the current program is intended to address these limitations in the use of GLEAMS in support of Forest Service activities. The Gleams-Driver program provides a relatively simple interface for conducting GLEAMS runs and using the results of these runs to estimate exposures to both adjacent fields and bodies of water (streams and ponds).

As detailed in this documentation, the Gleams-Driver program operates in two modes: Quick Run and Full Run. The Quick Run is intended for users with minimal familiarity with GLEAMS. It permits the user to perform exposure assessments based on a number of critical site-specific conditions, including weather patterns, soil types, and physical characteristics of both the treated field as well as the nontarget field and bodies of water. The Full Run allows users who are familiar with GLEAMS to employ a fuller set of site-specific exposure factors (e.g., multiple slope segments) and to employ Monte Carlo techniques to more fully capture uncertainties in the exposure assessments. Both Quick Runs and Full Runs should be much more useful to Forest Service personnel than the generic exposure assessments that are present in Forest Service risk assessments.

After a brief overview of the installation process (Section 2), this document describes the main program screen (Section 3) and the screens for each of the basic types of runs: Quick Runs (Section 4) and Full Runs (Section 5). In addition, this documentation describes various utilities built into the ***Gleams-Driver*** program (Section 6) and the algorithms used to estimate exposures

using output files from GLEAMS (Section 7). Lastly, this documentation gives an overview of the reports and databases generated by the ***Gleams-Driver*** program (Section 8). A list of references (both references cited and references consulted) is provided in Section 9.

As with previous versions of the documentation for using GLEAMS in Forest Service risk assessments (SERA 2000, 2004), this document as well as the Gleams-Driver program may be useful to individuals attempting to learn or become more familiar with GLEAMS but this documentation is not intended to serve as a tutorial for learning to properly apply GLEAMS. GLEAMS is a very complex model. **The user manual for GLEAMS (Knisel and Davis 2000) is the best source of information for learning to use GLEAMS and for developing GLEAMS simulations.**

In addition, this documentation for Gleams-Driver does not specifically address the merits of using the GLEAMS model in any particular application. Nonetheless, GLEAMS has been tested extensively for modeling pesticides (Cohen 1996; Connolly et al. 2001; Garnier et al. 1998; Leonard et al. 1987; Leonard et al. 1987; Sichani et al. 1991; Truman and Leonard 1991) as well as nutrients (e.g., de Paz and Ramos 2002; Djodjic et al. 2002), and results from GLEAMS are generally comparable to PRZM (Pesticide Root Zone Model), another root zone model developed and used by the U.S. EPA (Jones and Mangels 2002; Ma et al. 1999; Mueller et al. 1992; Parrish et al. 1992; Smith et al. 1991).

2. INSTALLATION

2.1. Pre-Installation

There is no reason to suspect that installing Gleams-Driver will harm your computer in any way. Nonetheless, you should back up all of your critical files and ***set a Restore Point*** before you install any program on your PC. A restore point allows you to bring your computer back to the same condition that is was in before you installed a program. Restore points are automatically set at varying periods by most newer windows operating systems.

To manually set a restore point, click Start/Programs/Accessories/System Tools/System Restore and then follow the instructions for creating a restore point. The restore point can be named anything that is meaningful to you – e.g., "Before Installing Gleams-Driver".

To actually restore your computer, follow the same set of procedures and select the option to *"Restore my computer to an earlier time"*.

2.2. Installation

The current release of Gleams-Driver can be downloaded from SERA's web site: www.sera-inc.com. Go to this web address and select the large tab labeled ***Gleams-Driver***. The complete installation package will be in a zip file. Unzip this file in any directory on your PC.

Two types of installation zip files may be found at the web site: a **full installation** indicating that all DLLs (dynamic link libraries) are included and a **light installation** indicating that few DLLs are included.

The full package with all DLLs should install and work on all PCs with Windows XP or Windows 2000. No problems involving a **full installation** have been reported except for issues associated with administrative privilege on some government PCs. If you are installing Gleams-Driver on you own PC, install the **full installation**.

Some users (particularly federal employees who are working on a network) may not have clearance or administrative privileges to use the full installation because the installation program for the full installation may want to update some existing DLLs. These individuals should try the **light installation**. The light installation works on PCs that have relatively recent and well-maintained versions of Microsoft Windows, MS Office programs, as well as some programming packages such as Visual Basic. On other PCs, however, the light installation may install without error but Gleams-Driver may not produce results or may generate runtime errors (Section 4.9). If this happens to you, you may have to use the **full installation** or you may need to install utilities and/or libraries that are available at www.microsoft.com. Further details on using the **light installation** as well as a discussion of **light installations** that result in Gleams-Driver not running correctly are given in Appendix 1.

The zip files for both light and the full installations contain a large file with the **CAB** extension, **setup.lst**, **setup.exe**, and a subdirectory named **Support**.
The file named **setup.lst** is a text file that contains a list of all files that will be installed on your system and indicates where these files will be installed. The **CAB** contains the main information for installing the program. This is a specially formatted file that you should not try to open. The **Support** subdirectory contains a number of additional files including DLLs, various Microsoft Access files needed by the program, help files, as well as various other supplemental files that are needed to install or run the program.

In the directory where you unzip the installation zip file – i.e., the directory with the large **CAB** file and **setup.lst** – the installation process is initiated by starting **setup.exe**. Do this by double clicking on **setup.exe** while in Windows Explorer. This will start the installation process, which is similar to that of most windows applications. After you select where you want the program installed, you may see a screen indicating that **Microsoft Data Access Components** (Version 2) is being installed. Gleams-Driver makes extensive use of Microsoft Access databases. The installation of **Microsoft Data Access Components** (Version 2) is necessary for Gleams-Driver. Some PCs will already have these components installed.

Gleams-Driver is written in Visual Basic 6.0 (SP6) and an effort has been made to use only common user interface tools (e.g., text boxes, text labels, drop down lists, etc.) to minimize the number of files that need to be copied to your PC. Nonetheless, you may get one or more messages that the installation program wants to copy a newer version of a file (most often a DLL) onto your PC, replacing an older file. Typically, common MS Windows DLLs are backward compatible and installing a newer version of the DLL will do no harm. Occasionally, however, installing a newer version of a DLL can cause conflicts with other programs. Again, because the DLLs used by Gleams-Driver are standard to most Windows operating systems, you may be able to run Gleams-Driver using older DLLs. Thus, during the installation process, you may be given the option to skip an update of a DLL. Doing this will probably not effect the running of Gleams-Driver.

In the development of this program, no DLLs were developed or customized and no third party DLLs are used. All DLLs that the program will install are DLLs obtained from Microsoft, either as part of Windows updates or as part of Visual Basic 6.0 (SP6).

2.3. Post-Installation

After the Gleams-Driver program is installed, the main program directory (i.e., the place where you installed the program, typically something like C:\Program Files\Gleams-Driver), will contain the following directory structure:

```
Main Program Directory
     GLEAMS Working Directory
     SupportFiles
     Locations
     Examples
```

The **Main Program Directory** will contain the Gleams-Driver program and **ST6UNST.LOG** (an uninstall text file discussed further in Section 2.4).

The **GLEAMS Working Directory** contains a copy of the GLEAMS program, **GLMS30.EXE**. **GLMS30.EXE** is necessary for the Gleams-Driver program to run. **GLMS30.EXE** is installed during the installation of the Gleams-Driver program. Modifications to **GLMS30.EXE** are not designated specifically by version or build number. The April, 2007 release of **GLMS30.EXE** is currently installed with Gleams-Driver.

The **SupportFiles** subdirectory contains four files: **Chemicals.mdb**, **Locations Available.mdb**, **RunTemplate.mdb**, and **Standard Soil Values.mdb**. **Standard Soil Values.mdb** is a standard Access database with information on soil parameters. If this file is not present, the Gleams-Driver program will not run. **Chemicals Available.mdb** and **Locations Available.mdb**, as the names imply, contain information about the chemicals and locations that are available to the program. The maintenance of these files are discussed further in Section 6.2. **RunTemplate.mdb** is used as the basis for creating Access input files, as discussed further in Sections 4 and 5. If **RunTemplate.mdb** is missing, you will not be able to run GLEAMS using Gleams-Driver.

The **Locations** subdirectories under the **SupportFiles** subdirectory contains the actual information that is needed by the program on locations. This information is stored in MS Access databases and these are discussed further in Section 6.1 (Weather Files).

2.4. Uninstalling

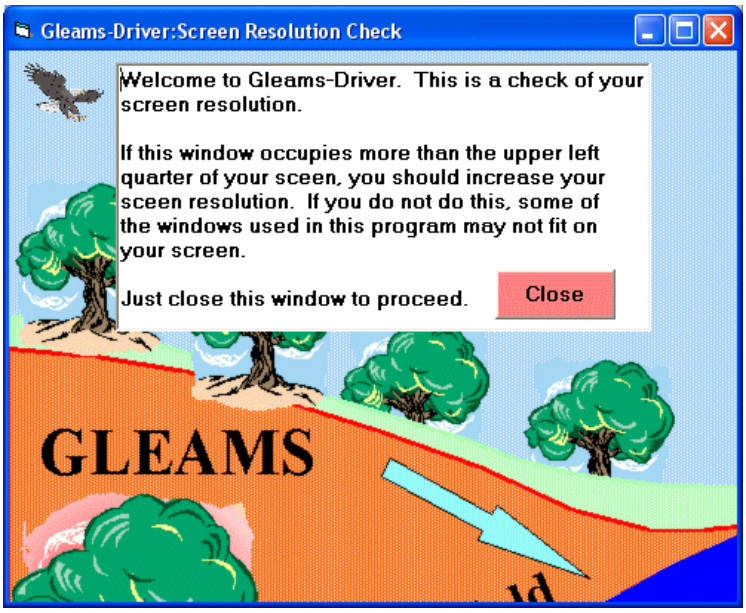
Gleams-Driver can be uninstalled like any other windows program by going to **Start/Settings/Control Panel/Add-Remove Programs**. The base directory where Gleams-Driver is installed contains a file with a name like **ST6UNST.LOG**. This is similar to **setup.lst** – i.e., it is a text file indicating what files were installed with Gleams-Driver and where the files were installed. You should never delete this file. If you delete **ST6UNST.LOG**, Gleams-Driver will not uninstall correctly.

Even after a normal and successful uninstall, you may get a message indicating that not all files could be removed. This simply indicates that you have created some files in the program directory or a program subdirectory that were not originally installed with Gleams-Driver. This is normal and the files and/or subdirectories can be manually deleted.

3. Main Screen

3.1. Overview

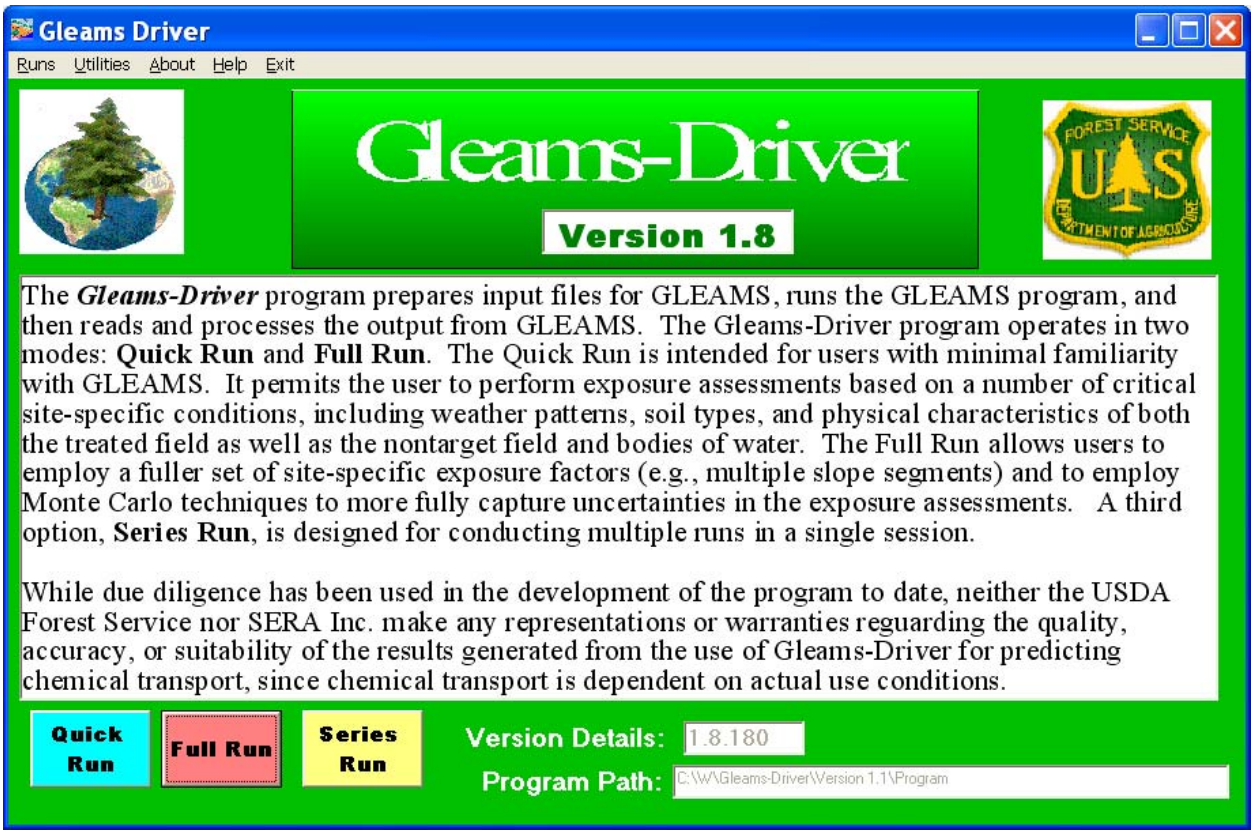
The first time that you run Gleams-Driver, a **Screen Resolution Check** window will appear in the upper left hand corner of your screen. As indicated on this window, the Screen Resolution Check should not occupy more than the upper left quadrant of your screen. If it occupies a larger space and you continue, some of the other windows used by Gleams-Driver will exceed the size of your screen. If the Screen Resolution Check window is too large, you should increase your screen resolution. This check will only happen the first time that you run Gleams-Driver. When this check is completed, a plain text file, **ResolutionCheck.Txt**, is written to the directory where Gleams-Driver is installed. The existence of this file suppresses the Screen Resolution Check window.



Screen Resolution Check window is followed by a **Checking Installation** window, as illustrated in Figure 1. As the name implies, this screen indicates that the program is determining if the installation was successful and that all necessary files are installed in the correct directories. This check will be made each time that Gleams-Driver is started.

Each time Gleams-Driver is started, another plain text file is created and this file is named **Errors in Gleams Driver Run.txt**. Any errors that are encountered during a session of running Gleams-Driver will be sent to this file. This file may also contain warning messages. These will typically relate to internal adjustments that Gleams-Driver may have needed to make to your input data. These will not necessarily be a problem but are adjustments that you should be aware of. In addition, this file will provide statistics on the number of simulations conducted by the program and the time that was required to complete the simulations.

You should look at **Errors in GLEAMS Driver Run.txt** regularly. Various screens may indicate that errors have occurred but **Errors in GLEAMS Driver Run.txt** will provide more detailed information. These error messages will mention various classes and specific class functions. If you are not familiar with the source code, these may have limited meaning to you. Nonetheless, if the errors appear to involve user inputs, the error messages may help you to correct the errors.



After the installation check is completed, the main program screen will open. This screen is illustrated in Figure 2 and is also included at the top of this page. The Main Screen can be used to initiate Quick Runs (Section 4) or Full Runs (Section 5) either by pressing the buttons or selecting the menu items (i.e., Runs/Quick Run or Runs/Full Run). The main screen is also used to access utilities (discussed in Section 6).

3.2. Series Run

The main screen has not only the **Quick Run** and **Full Run** buttons but also a **Series Run** button. This is a very simply utility that allows you to do any number of Gleams-Driver runs. To do a series run, put all of the Access input files into a single directory. These input files can be created using either the Quick Run or Full Run facilities or any combination of the two. Press the **Series Run** button and then use the Set button to navigate to the directory where you have the Access input files and specify the name of a Series Driver file. The Series Driver file will be created by Gleams-Driver and will contain the names of the Access input files in the directory. The **Series Run** utility will then start the first simulation and move on to each of the remaining simulations. The Abort button on the **Series Run** form can be used to halt the series at any time. The program will not stop, however, until the simulation that is in progress is completed. The series can then be restarted at the previous stop point at a later time. [If you really need to

stop the program, you can do so with the Windows Ctrl-Alt-Del facility. This will do no harm. The only consequence is that program will have to start the simulation that you halted from the beginning.]

As discussed more fully in Section 8.1 (Error Files), automatic run-specific error reporting is suppressed during a Series Run. This error suppression is necessary in order to allow other runs to proceed – i.e., if you a doing 10 runs overnight, you would not want an error or warning in the second run to stop all of the other runs from proceeding. **Thus, before using any results, you should check each run-specific error file after a Series Run is completed.** See Section 8.1 for details of the run-specific error files.

While the Quick Run (Section 4) and Full Run (Section 5) features are discussed in some detail in this documentation, the Series Run is not discussed further. The Series Run is a very primitive and simple utility. Nonetheless, the Series Run may come in handy if you need to do a large number of simulations that will take a long time to complete (e.g., if you are doing multiple sites or chemicals or if you want to do a sensitivity analysis). Using the Series Run, you can start the simulations and let them run overnight or over the weekend as needed.

3.3. Version Information and Help Features

Lastly, the Main Screen specifies the version of Gleams-Driver that you are using. In Figure 2, the version is **`1.8.180`**. As discussed further in Section 6.6, the last number, **`180`**, is a ***build number***. Each time that the program is compiled, a new build number is assigned. As various minor changes are made to the program, the build number will increase (i.e., be incremented). Thus, the version **`1.8.180`** designation indicates the **`180`**th build of Gleams-Driver. This build was current at the time this documentation was written but before the final release data of Version 1.8. The build number will be different (greater than 180) on the copy of Gleams-Driver that you are running.

Each program screen is set up so that positioning the cursor over a particular part of the screen (e.g., a button or text box) will show a "Quick Tip" that provides information about the item that the cursor is over. In addition, Gleams-Driver has standard Windows Help. This can be accessed by selecting the Help menu item on the Main Screen or by pressing the F1 (Help) key at any time. All of the screens in Gleams-Driver have context sensitive help. This feature is most fully developed in the Quick Run screen (Section 4).

4. Quick Run

Quick Runs are designed to allow you to take advantage of many of the options in both GLEAMS and Gleams-Driver with minimal effort and using terminology and descriptions that will be familiar to many individuals in the Forest Service. A Quick Run is actually two runs that are conducted simultaneously: one run for a nontarget (untreated) field that is immediately adjacent to the treated for field (Section 4.5) and the other for a body of water (that can be specified as a stream or a pond) that is immediately adjacent to the treated field (Section 4.6). Internally, Gleams-Driver distributes all of the pesticide losses from GLEAMS as well as any drift specified by the user to both of the nontarget sites, the water and adjacent field. Again, this essentially constitutes two different Gleams-Driver runs.

A Quick Run is useful for conducting preliminary exposure assessments using many factors that can be characteristic of a particular program activity, region, and geographic location. While a Quick Run does not use all of the capabilities of a full run (Section 5), a Quick Run can provide estimates of exposure that may be far more useful in an environmental assessment or EIS than any of the generic exposure estimates in standard Forest Service risk assessments.

The Quick Run screen is illustrated in Figure 3. The screen is divided into seven areas:

General Run Information (band across the top of the screen)
Treated Site
Application
Soil
Nontarget Site
Water Body
Run Status and Options (band across the bottom of the screen)

Each of these screen areas has a title area in bold green text in Arial Font with a white background. If you click within these title areas, a help window for the area will open. This help window will give you a general overview of the information that you may enter or change.

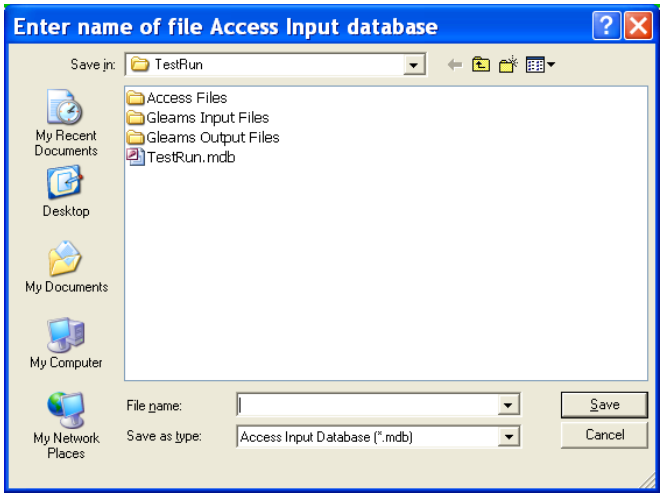
Each of the seven screen areas listed above are discussed in the subsections below. For convenience, each of these subsections includes non-numbered and non-titled embedded figures of sections of the Quick Run screen (Figure 3) that are being discussed.

4.1. General Run Information

The top part of the Quick Run screen specifies general information about the run: the **run series name**, the name of the **driver file**, the **number of weather-year sets**, the number **repetitions per weather-year set**, a **random seed**, and the **Weather Year Offset** (discussed further below).

In the Quick Run window, the name of the **Driver File** is the only field on the entire form that needs to be completed before the run can begin. The name of the driver file is the name of the MS Access database file that will hold all of the input data for the run – i.e., **the Access input database**. This file is discussed in greater detail in Section 5 (Full Run). The driver file should be specified using the **Set** button on the right side of the text field that contains the driver file name.

Pressing the **Set Button** to the right of the **Driver File** will open a standard file dialog box (illustrated to the left). Use the normal windows navigation tools to locate (or create) the directory where you want to store the results of the run. Type in the name of the MS Access database file that you want to create as the driver file in the file name box. Note that you can select a driver file that already exists. Doing so, however, will overwrite any run specific information in the driver file. Unless you plan on using the driver file as a template for a full run (Section 5), you may not care about this.



The **Simulation Name** can be any descriptive title that is meaningful to you. This name is used to set the name of **the Access output database** (Section 8.3).

The General Information area also allows you to specify the number of **Weather-Year Sets** and the number of **Repetitions per Weather-Year Set**. Each Gleams-Driver run requires a data file with weather information. Each of these files must contain a full year of weather information for each full or partial year that you are including in the simulation. These weather files are referred to as **Weather-Year Sets**.

If you are not doing repetitions on the weather-year sets, the number of weather-year sets is equivalent to the number of simulations that you want to do. Otherwise, the number of simulations is the product of the number of weather-year sets and the number of repetitions per set.

The ability to specify both the number of weather-year sets and the number of repetitions per set reflects the two sources of variability and/or uncertainty that Gleams-Driver will simulate:

variability in weather patterns and variability in other model input parameters such as chemical or soil properties. [In discussing Monte Carlo simulations, a distinction between uncertainty and variability is often made. For the sake of simplifying this discussion, the term *variability* is used to encompass both uncertainty and variability.]

As discussed in 6.1, variability in weather patterns is handled by Gleams-Driver through the use of weather data generated by Cligen, a climate simulator. Other forms of variability are handled internally by Gleams-Driver using random number generators for various distributions (discussed further in Section 5 and Section 6.4).

Note that the number of weather-year sets that you can specify is limited by the number of years in the database for the location that you have selected. For example, if you a doing a run that requires 3 weather years for each run and you specify that you want to do 500 simulations, you would need 1500 years of data. In terms of the location file that you are using, this file would actually need to have 2000 years of data because Gleams-Driver (and GLEAMS) are sensitive to leap years.

The number of weather-year sets that you need will depend on the Start Date and End Date for the simulations that you specify on the **APPLICATION** section of the Quick Run form. For example, if you a doing a run that starts on July 1, 2002 and ends on July 1, 2004 (i.e., a two year period), the Gleams-Driver run will start on January 1, 2002 and end on December 31, 2004, thus using 3 years of weather data rather than two.

This can get rather complicated. As a convenience, Gleams-Driver will check the Location file that you have specified against the number of Weather Year Sets that you enter. If there are not enough years in the location database, Gleams-Driver will reduce the number of Weather-Year Sets to the maximum number that the location database will support.

The repetitions of weather-year sets is the number of simulations that you want to do for each weather-year set that you are running. In these repetitions, the same weather-year set is used repeatedly for the number of times that you specify. In these repetitions, however, the other model parameters, such as rates of degradation, are allowed to vary. This variability within each repetition will occur in a Quick Run only if you checked one or more of the check boxes for using default variability as discussed further below (Section 4.3 for soil, Section 4.4 for applications, and Section 4.6 for bodies of water).

Users who are doing a Quick Run simply to get a general sense of the results for a site or region will typically want to leave the number of repetitions at the default value of 1 – i.e., every simulation will involve variability in weather patterns as well as variability in other model parameters. Conversely, individuals who are interested in the impact of a single model parameter (e.g., drift) or group of model parameters (e.g., soil) under a fix set of weather conditions might want to set the number of Weather-Year simulations to 1 (i.e., use only a single set of weather data in the simulations) and specify a number (perhaps a large number) of repetitions. This type of run can be used in what is referred to as Sensitivity Analysis. Some

users may want to allow variability in weather-year sets as well as allow the other model parameters to vary a fix number of times for each set of weather-year simulations. This is sometimes referred to as a Two-Dimensional Monte Carlo simulation.

The total number of simulations that you will run will be the product of the number of weather sets and the number of repetitions per weather set. Note that the box showing the **Total Number of Simulations** is calculated from the number of weather-year sets and the number of repetitions per weather year set. You cannot change the value of the total number of simulations directly.

As discussed in Section 4.4, the starting and ending years for the simulation are entered in the Application section of the Quick Run form. The starting years and ending years are used merely to determine the number of years that each simulation will cover. In other words, starting at year 2000 and ending at year 2003 will give you the same results (all other things being equal) as using a starting year of 2004 and an ending year of 2007.

These are mentioned here because they interact with the field in the General Information section that is labeled **`Weather Year Offset`**. Both GLEAMS and Cligen are sensitive to leap years and thus Gleams-Driver is sensitive to leap years as well. Using a starting year of 2000 (a leap year) and ending at year 2001 would lead to a 731 day simulation whereas using a starting year of 2001 and ending at year 2002 would lead to a 730 day simulation.

Leap years impact the use of location/weather files. As discussed more fully in Section 6.1, location files contain basic information on the geographic location of a site (e.g., latitude, longitude, and elevation) as well as daily, monthly, and yearly sets of weather statistics (e.g., temperature, wind speed, and precipitation). Each location/weather file is an MS Access data database that has been generated from a Cligen text file (USDA/NSERL 2005). Cligen is another program developed by the USDA/ARS as a climate generator or simulator.

In doing a simulation, the Gleams-Driver program notes the starting year that you have specified and the field labeled **`Weather Year Offset`**. The **`Weather Year Offset`** is simply the first year from the appropriate Access database that will be used in the simulation. The Gleams-Driver program will ensure that the starting year and the **`Weather Year Offset`** are synchronized in terms of the occurrence of leap years. For example, if you specify a starting year of 2002 (i.e., 2 years until the occurrence of a leap year) and attempt to use the default **`Weather Year Offset`** of 1 (3 years until the first leap year), the Gleams-Driver program will automatically adjust the **`Weather Year Offset`** to 2 (i.e., 2 years until the first leap year).

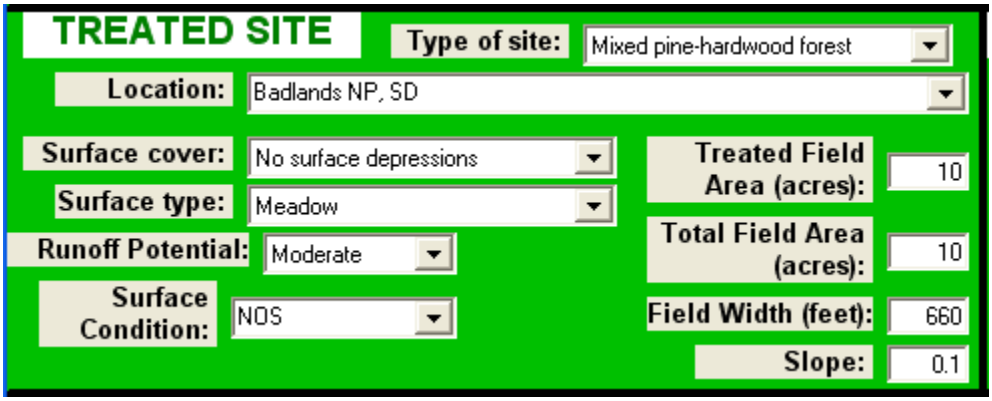
Users who are exploring the impact of differing rainfall patterns with small numbers of simulations can also change the **`Weather Year Offset`** to any value that they choose (within the limitations of the number of years that are in a particular location/weather file). Thus, rather than using a **`Weather Year Offset`** of 2 with a starting year of 2002, the user could enter a starting year of 10. This value would be accepted by the program and would result in the use of a different set of rainfall values for the run. As with the default year for the

`Weather Year Offset`, the program will check any value for **`Weather Year Offset`** that is entered by the user and will adjust the value to be in synchrony in terms of the occurrence of leap years with the start year entered by the user.

The last field in the General Information of the Quick Run form is the **Random Number Seed**. The **random seed** can be used to enter a numeric value that sets the initial conditions of the random number generator. This field should be set if you are using the Monte-Carlo capabilities of Gleams-Driver and you want to ensure that your Monte-Carlo analysis is reproducible. If you do not set the random seed, the random number generator will be initialized by the system clock (i.e., using the date and time that you start the simulation). This will lead to a different set of results each time you do the simulation and the results will not be reproducible by others. The Monte-Carlo capabilities of Gleams-Driver are discussed further in Section 5.4 (Full Run Monte Carlo Simulations) and Section 6.5 (Testing Random Numbers). Note that the random seed does not impact the selection of rainfall patterns. The random variability of rainfall is set in the Cligen run that is used to generate the locations/weather Access database files (Section 6.1).

4.2. Treated Site/Field

Information on the treated field/site is contained just below the **GENERAL INFORMATION** section on the left side of the Quick Run form. This section of the form allows you to specify the geographic location of the field, the type of site, surface cover characteristics and conditions, a general classification of runoff potential as well as the area of the field that is being treated, the total area of the field (treated and untreated), the width of the field and the slope of the field. The available choices for the location (i.e., geographic location) of the site are presented in a combo box.



If you specify a treated field area of over 640 acres, you will get a warning message indicating that you are trying to model a very large field. You can disregard this message but you should appreciate that GLEAMS is a field-scale model. The capabilities of GLEAMS to model water balance at the field level has been demonstrated but the watershed used in this evaluation covered only a 0.35 hectare or about 0.8 acre area (Knisel et al. 1991). In an ongoing evaluation of Gleams-Driver, field areas used in the assessment of hydrologic processes vary from 47 acres to about 1,700 acres. A field area of 47 acres is equivalent to about 20 hectares, about twice the size of the standard pond used in many U.S. EPA risk assessments. While the ongoing evaluations of Gleams-Driver suggest that Gleams-Driver may be able to reflect the gross hydrology of drainage areas up to about 1700 acres, the evaluation of monitored pesticide concentrations is limited to 47 acres.

It is not clear from the current evaluation that Gleams-Driver can be applied with confidence at the scale of large water basins. Other models such as the Soil and Water Assessment Tool (SWAT, http://www.brc.tamus.edu/swat/) and the Annualized Agricultural Non-Point Source model (AnnAGNPS, http://www.ars.usda.gov:80/Research/ docs.htm?docid=5222) are available for modeling large water basins but the use of these tools is much more complex and data intensive than the use of Gleams-Driver. Again, Gleams-Driver is a relatively new tool that is still under evaluation and caution is advised in apply Gleams-Driver to larger watersheds.

A combo box in the Treated Site section of the Quick Run screen is a common user interface tool in Windows applications that combines the properties of a text box and a list. If you press on the down arrow symbol on the right hand side of the box, you will be presented with choices. For the locations combo box, the available locations reflect the location/weather databases that are in the standard installation subdirectory: **`\SupportFiles\Locations`**.

To simplify installation and limit the size of the installation files, Gleams-Driver includes location/weather files for only nine standard test sites and each file covers a period of only 24 years. It is anticipated that individuals using this program will create their own location/weather files relevant to their particular location using the utility described in Section 6.1.

Summary statistics for each of the 9 sites selected as standard test sites for Gleams-Driver are summarized in Table 1. Except for Quillayute, Washington, all of the selected test sites are included in WEPP. For Quillayute, Washington, latitude and longitude were used to develop the simulation. In terms of the user interface for the Quick Run, the sites are identified by the combination of precipitation and temperature given in Table 1. For example, the climate file for Hilo, Hawaii is identified as "Warm Wet". This approach is taken because the files for the standard test sites are intended only to allow the user to explore different results with changes in general climate patterns.

The type of site is also presented in a standard combo box and the available choices are taken from the categories defined in GLEAMS as the variable **`FOREST`**:

agricultural field application
long leaf conifer forest
short leaf conifer and cedar forest
mixed pine-hardwood forest
hardwood forest.

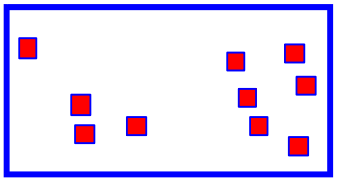
The surface type, surface cover, surface condition, and runoff potential fields are also selected with combo boxes. These boxes are used together to select the Soil Conservation Service (SCS) curve number for moisture condition II (Knisel and Davis 2000, pp. 24-26). The choices available for surface cover will vary with the selected surface type. All of the choices parallel choices available in the documentation for GLEAMS.

The separate entries for treated field and total field area are intended to allow the user to reflect a

situation where only part of a water drainage area is being treated. GLEAMS uses information only on the treated field. The post-processor algorithms in Gleams-Driver (Section 7) use information on the area of treated field to estimate pesticide loss to a pond or stream. The total field area, however, will be used to estimate the amount of water added to the stream or pond by runoff. The distinction between the treated field area and total field area will impact the results only if water balance is considered. This is discussed further in Section 4.6 as well as Section 7.6.

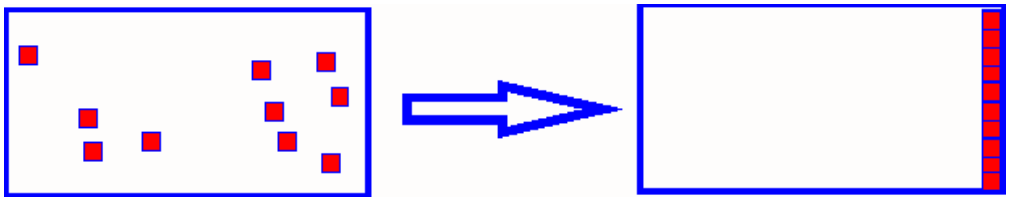
At this time, the use of the treated field area and total field area is the only method for dealing with spot applications. These two input parameters are located in the **Treated Site** area of the Quick Run form.

Take for example the illustration below in which 10 spot applications are made to a field as illustrated to the right.



This type of application cannot be input directly into GLEAMS and therefore it cannot be directly input into Gleams-Driver. Instead, you need to determine or at least reasonably estimate the total number of acres that are treated as well as the total area in which the spot treatments occur.

The above example was constructed to illustrate 10 spot applications that are 1 square yard each and that are made over an area that is approximately 20 by 10 yards or 200 square yards. In terms of modeling this type of application in Gleams-Driver, you would basically view the treated field area as 10 square yards and the total field area as 200 square years as illustrated below:



This approach is best reserved for relatively uniform applications and some judgement may need to be used in selecting the total area that might drain into a nontarget field or body water.

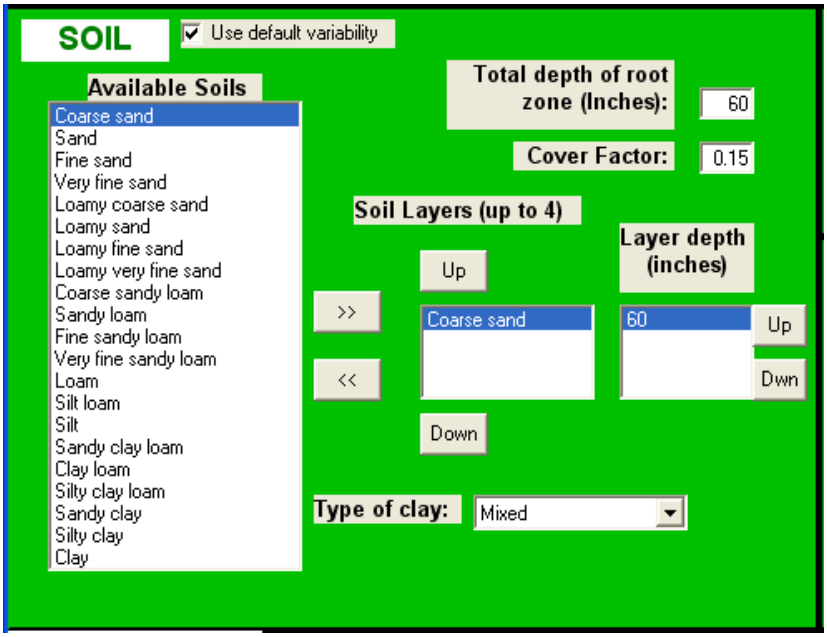
The width of the field corresponds to the length of longest flow path in the GLEAMS documentation (Knisel and Davis 2000, pp. 26-27). Think of this as the length of the flow path from the highest point of the field to the point where runoff would occur to a nontarget field or body of water. This distance should be entered in feet.

The slope of the field entered into this section of the Quick Run screen is a composite of the physical slope of the overland flow profiles (Knisel and Davis 2000, p. 64) and the hydraulic slope of the field (Knisel and Davis 2000, pp. 26). This is one of the major simplifications in the

Quick Run compared to a Full Run. If you are doing a site-specific assessment, you should be able to reasonably estimate the hydraulic slope distinct from the physical slope and you may have multiple overland slope segments. All of these factors can be included in a Full Run (Section 5) but are not included in a Quick Run.

4.3. Soil

The section of the Quick Run form that deals with soil is immediately below the section dealing with the Treated Site (Section 4.2). The section on soil is used to describe the soil or soils at the treated site.



Immediately to the right of the **SOIL** label is a check box that is labeled **"Use default variability"**. Similar check boxes are included in the **Application** area (Section 4.4) and **Water Body** area (Section 4.6).

In the soil section, checking this box will add variability to several of the properties of the soil or soils that you are modeling. For each property, the initial default is a Triangular Distribution in which the mode is the taken as the estimate in the soil database. The lower limit is 0.5 of the mode and the upper limit is twice the mode. This default distribution can be changed in the Full Run edit screen.

The major part of the soil area involves two lists: Available Soils and Selected Soils. The available soils are taken for the most part from soils described in the documentation for GLEAMS (Knisel and Davis 2000: Table H-3, p. 46; Table H-5, p. 48; and Table E-1, p. 90). These selections correspond to entries in the Access database, **`Standard Soil Values.mdb`** (**`SoilProps`** table), that is installed with Gleams-Driver. These values are summarized in Table 2 with additional details give in Tables 3, 4 and 5. Most of these values are default values recommended by Knisel and Davis (2000). At the request of the Forest Service and Park Service, additional default values have been provided for volcanic pumice and two organic soils, peat and muck. These are discussed in Appendix 3.

Some soil properties are interrelated and most soil properties are physically limited in the range of values that are plausible. Thus, as noted in Tables 3, 4 and 5, many of the specific soil parameters are constrained internally by Gleams-Driver.

Knisel and Davis (2000) do not provide default values for organic matter. The values for organic matter given in Table 2 are based on an analysis of data provided in the USDA/ARS Pesticide Properties Database. Details of how these values were derived are given in SERA (2006a).

The soils from the Available Soils list box can be moved to the Soils Layers list box by either selecting the soil and using the add button (>>) or by selecting and double clicking on the soil in the Available Soils list box. Soils in the Soils Layers list box are used in the GLEAMS modeling. Soils can be removed from the Soils Layers list box by either selecting the soil in the Soils Layers list box and activating the remove button (<<) or by selecting and double clicking on a soil in the Soils Layers list box. The program will not allow you to remove all soils from the Soils Layers list box. Thus, if you want to remove the soil type that is in the Soils Layers list box by default, you must first add a soil type. Up to four soil layers can be selected (this is the limit in GLEAMS) and the same soil type may appear in more than one layer.

You can control the order of the soils in the Soils Layers list box using the Up and Down buttons that are immediately above and below the list box. The total depth of the root zone can be entered in a separate text box labeled Total Depth of Root Zone (Inches). This depth is used to automatically set the lowest depth of the bottom soil layers. The depth of each soil layer is shown in a separate list box immediately to the right of the Soils Layers list box. These depths can are automatically set by the program as soils are added or removed from the Soils Layers list box. The final depths of each soil layer can be set by selecting the soil layer in the Soils Layers list box and using the Up and Down buttons that are immediately to the right of the Soil Depths list box. The soil depths can be adjusted in this manner only in units of whole inches. If you need a finer scaling, you will need to use the features of the full run.

The other fields in the soil section of the Quick Form are the **Cover Factor** and the **Type of Clay**. The **Cover Factor** corresponds to **CFACT** in the documentation for GLEAMS (Knisel and Davis 2000). As discussed in some detail by Knisel and Davis (2000, p. 82ff), the sensitivity of **CFACT** in estimates of sediment yield will vary with the contour of the field.

The cover factor refers to the impact of the canopy cover over the soil surface on soil erosion. The Cover Factor must be a value from 0.0 to 1.0:

0.0 = Full canopy cover, no soil should be eroded.
1.0 = Bare ground with no foliar interception of rain.

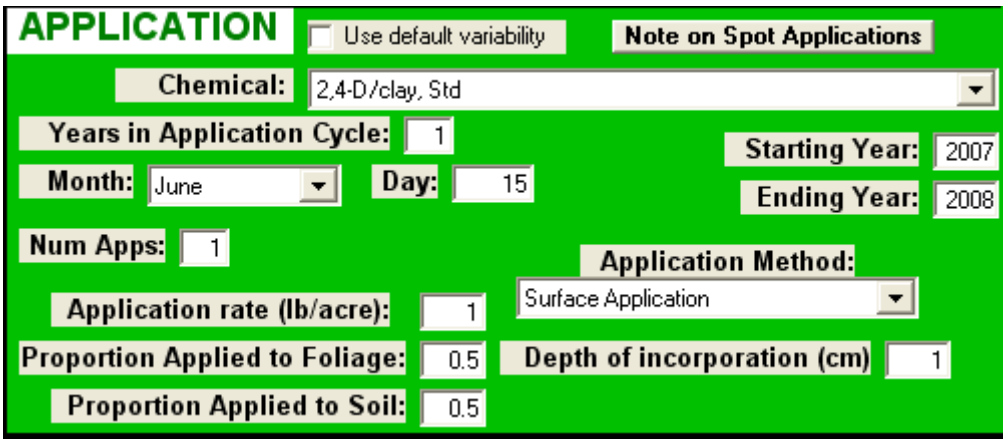
You will probably not want to use either of these extremes. After the emergence of some weeds and/or grasses, values of 0.9 to 0.95 would be reasonable. For a full canopy of pine trees with straw under the trees, a reasonable value would be 0.01.

Note that **CFACT** is an updateable parameter in GLEAMS - i.e., the cover can change as the season changes. In a Quick Run, however, only a single value is used. If you want to make this parameter vary of the course of the simulation, you will need to do a Full Run.

The last field in the soils section of the Quick Run screen involves the type of clay. Three choices are available in the Quick Run list box for the type of clay: kaolinite, montmorillonite, and mixed. The selection in this list box is used to set the specific surface area of clay. This is the **SSCLY** parameter discussed in the documentation for GLEAMS (Knisel and Davis 2000, p. 72ff).

4.4. Application

The application area of the Quick Run form is just below the general information section on the right side of the Quick Run form. This section of the Quick Run form allows you to enter information about what pesticide is being applied, the application rate, the time of the application, and method of application.



This area also contains a button labeled Note on Spot Applications. Pressing this button will provide help in using Gleams-Driver to model spot applications. As detailed in Section 4.2 (Treated Site/Field), the best approach to modeling spot applications is to determine the approximate amount that you will apply per acre and enter this in the application rate box. This will functionally treat the spot application as a broadcast application although you can still set the FOLFRC and SOLFRC to mimic the type of spot application.

As with the Soil area of the Quick Run screen, a check box that is labeled **"Use default variability"** is immediately to the right of the **APPLICATION** label. Checking this box will add default variability to several of the properties of the chemical that you are modeling. As with the check box in the soil area, the initial default is a Triangular Distribution in which the mode is the taken as the estimate in the chemical database. The lower limit is 0.5 of the mode and the upper limit is twice the mode.

Similar to the available sites, the pesticides available in the pesticide combo box will depend on the files in the that are in **Chemicals.mdb** the standard installation subdirectory: **\SupportFiles**. The **Chemicals.mdb** database that is installed with Gleams-Driver includes all of the chemicals (i.e., herbicides, insecticides, and hexachlorobenzene) for which GLEAMS runs were conducted in Forest Service risk assessments. Details of the information in this database as well as the specific data source are given in SERA (2006b).

Note that each chemical has three entries designated by soil texture: clay, loam, and sand. This approach is taken because the binding characteristics of all of the chemicals included in **Chemicals.mdb** are influenced by the specific characteristics of different soils. This is discussed further in SERA (2006b).

Note also that each chemical in the list ends with ", Std" This simply designates that the data is taken from the standard values in the Gleams-Driver release. While this is not a central concern in doing a Quick Run, you should appreciate that many if not all of the chemical properties that will impact the output from Gleams-Driver can and will vary from site-to-site and soil-to-soil. This is one of the reasons that the default variability option has been added to this section of the Quick Run screen.

Because the chemical properties can be extremely variable and because new information may be available to you when you conduct the Quick-Run, a utility is available from the main window for importing information on *new chemicals* into this database (Section 6.3). The term *new chemicals* is given in italics here because the chemical itself (e.g., 2,4-D) may already be in the database but you may need to add a separate entry for this chemical to better reflect either site-specific conditions or new information. In such a case, you should select a name for the chemical/site that will differentiate this entry from the standard value such as *2,4-D/sandy loam, Oregon*.

The Application area of the Quick Run screen also contains the starting and ending years for the simulation, as discussed in Section 4.1. These merely determine the number of years in the simulation. In both the Quick Run and Full Run, the chemical is applied once per year. You are also able to specify the month and day on which the chemical is applied. Note that the day is taken simply as an offset to the month. Thus, if you enter March 44, the day of application is taken as March 1 plus 44 days. Note that the starting and ending year can be the same. In this case, however, you will not be modeling a full year after the chemical is applied. This will lead to lower time-weighted average values in the Gleams-Driver output than if you have monitored for two or more years. While this may not be an error, a warning note indicating the underestimates will be given in the Gleams-Driver Error File (Section 8.1).

The proportion applied to foliage and the proportion applied to soil correspond to the FOLFRC and SOLFRC parameters in GLEAMS. These are discussed by Knisel and Davis (2000, p. 111).

Application rates should be entered either as lbs a.i./acre or lbs a.e./acre. The choice may not always be obvious. In general, enter application rates for weak acids as lbs a.e./acre and use lbs a.i./acre for other compounds. If you are applying an ester of a weak acids, what you enter (a.e. or a.i.) will depend on what you are modeling. Many esters break down relatively rapidly and you may elect to treat and model the ester as the weak acid, using the chemical and physical properties of the acid rather than the ester. A better approach, however, may be to model the ester and the acid separately because peak exposures to esters may sometimes present significantly different (and often greater) risks than the corresponding weak acid.

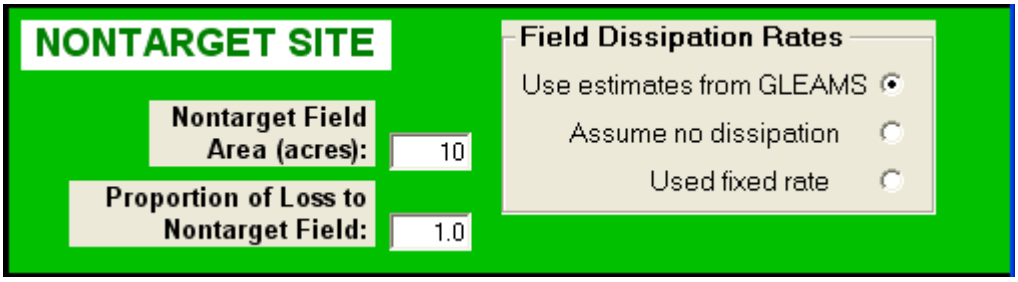
You may also enter values for the **Years in Application Cycle** and **Number of Applications**. The years in the application cycle refers to the length of time between the applications. If the applications are made each year (which is the default in a Quick Run) use a value of 1. If the applications are made only every fifth year, use a value of 5. The years in the application cycle corresponds to **IROT** in the GLEAMS pesticide field and **NYEARS** in the GLEAMS hydrology file. See the GLEAMS documentation (Knisel and Davis 2000) for additional details.

The number of applications simply designates the number of times that the pesticide will be applied in an application cycle. The **Year** and **Day** fields in this section of the Quick Run screen indicate the date on which the first application is made. If you specify a value of greater than one in the **Number of Applications** field, another field will become visible in which you can enter the **Interval Between Applications**. The interval field is illustrated in Figure 3. This interval must be specified in days. If the number of days is equal to or greater than one year, you should handle this with the **Years in Application Cycle** field. If you are really trying to characterize a complex series of widely spaced applications, edit the application dates using the Full Run utility.

4.5. Nontarget Site/Field

Information on the **NONTARGET SITE** is located immediately below the **APPLICATION** section on the Quick Run form. The nontarget site is modeled as a field that is immediately adjacent to the treated field. As noted in the initial description of the Quick Run at the start of Section 4, the Quick Run is actually two runs that are conducted simultaneously in which all losses from GLEAMS are directed to both a nontarget field and to a nontarget body of water. This section of the Quick Run screen allows you to control how losses are handled in the nontarget field.

As noted in Section 1,



GLEAMS is an edge-of-field model and does not specifically consider deposition or persistence of a pesticide on an adjacent field. In generic exposure assessments presented in Forest Service risk assessments (SERA 2000, 2004), the assumption is made that the nontarget field is essentially identical to the treated field. The cumulative proportion of runoff and sediment is used to calculate a functional offsite application rate assuming no degradation. The limitations in this approach are obvious. For a generic assessment, however, no preferable alternative is evident and none have been suggested by reviewers.

In the current Gleams-Driver program, the user may enter the area of the offsite deposition as well as the proportion of loss (runoff and sediment) from the treated field that is deposited to the

nontarget field. This option is intended to allow for sites in which a large treated area may be a adjacent to a smaller nontarget area (higher risk). Conversely, these options allow for a relatively small treated area to contaminate a much larger untreated are (lower risk). How the user selects the area of the nontarget field and the proportion of the contamination to the nontarget field will depend on the configuration of the treated and untreated sites, and no more specific guidance seems warranted. As with all aspects of any exposure assessments, the rationale and justifications for all assumptions should be clearly stated.

This section of the Quick Run form also offers three choices for considering degradation: a default approach based on the behavior of the chemical at the treated site (Section 7.3), the use of a fixed field dissipation rate, and the assumption that no degradation occurs. If the user elects to use a fixed dissipation rate, the text box will appear where the dissipation rate can be entered in units of $days^{-1}$. If a field dissipation halftime is available, this can be converted to a field dissipation rate (k) using the following relationship: $k = \ln(2) \div halftime$.
Note that drift to the nontarget field is not specifically set in this section of a Quick Run form. As discussed below, a drift value as a proportion of the application rate is entered for a nontarget water body and this drift value is used for the nontarget field. In other words, a Quick Run is actually two runs combined, one contaminating a nontarget field and the other contaminating a body of water. In a Full Run, multiple values can be entered for drift to one or more nontarget fields as well as one or more bodies of water (Section 5).

4.6. Nontarget Water Body

Information on the **WATER BODY** is located immediately below the **NONTARGET SITE** section on the Quick Run form. The water body is modeled as a nontarget body of water that is adjacent to the treated field. As noted Section 4.4 (Nontarget Site) as well as in the initial description of the Quick Run at the start of Section 4, the Quick Run is actually two runs that are conducted simultaneously in which all losses from GLEAMS are directed to both a nontarget field and to a nontarget body of water. This section of the Quick Run screen allows you to control how losses to the nontarget body of water are handled and allows you to define the type of water body as a pond or a stream.

In a Quick Run, the body of water is always referred to with the code **WatBod01** and this cannot be changed by the user. In a Full Run, a common name and a user defined code can be used. The main choice for the user is given in a combo box used to indicate the type of water body: a stream or a pond. Depending on this selection, different inputs will be available.

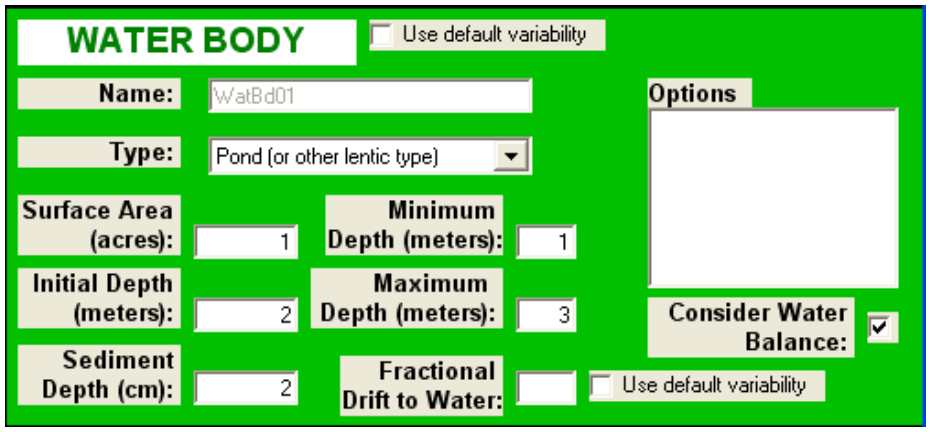
As with the **SOIL** and **APPLICATION** areas, a check box that is labeled "Use default variability" is immediately to the right of the **WATER BODY** label. As currently implemented, checking this box will add default variability only to the sediment depth of the pond. This will not have a major impact on the results for most chemicals.

Note, however, that another check box is included to the right of **Fractional Drift to Water** text box. Checking this box will add default variability to drift to both the water body that you are modeling as well as the nontarget field. As with the other sources of default variability, the

initial default is a Triangular Distribution in which the mode is the taken as the estimate that you have entered into the drift text box. The lower limit is 0.5 of the mode and the upper limit is twice the mode. **Drift is an extremely sensitive parameter for your simulation.** For both the water body and the nontarget field, a substantial drift may result in a much greater impact on the water body and the nontarget field than the losses from the treated field itself that are modeled by from the GLEAMS output.

Drift can be a very important parameter in deposition to the offsite field as well as the nontarget water body. Gleams-Driver has no utility for estimating drift. These estimates can be taken from other modeling programs (e.g., AgDisp or AgDrift), representative monitoring data, or default values (e.g., 0.1) can be used. If modeled estimates are used, the fraction used should be the approximate average drift over the entire width of the pond or stream.

4.6.1. The Pond



For a pond, the user can input the surface area of the pond, initial, minimum, and maximum depth of the pond, the depth of the sediment in the pond, the fractional drift (i.e., the fraction of the application rate) to the pond from the application site, and options the impact the behavior of reservoirs as detailed in Section 4.6.4 Lastly, the user can check whether or not water balance is to be considered. The specific algorithms are given in Section 7.4.

The surface area of the pond is used with the value for drift to calculate the amount of the pesticide that is deposited into the pond.

The initial, minimum, and maximum depths interact with the check box on water balance. If water balance is NOT checked, rainfall, runoff, and precipitation are not used to adjust the volume of the pond and only the value of the initial depth is used with surface area to calculate the amount of water in the pond. This in turn is used to calculate the concentration of the pesticide in the water. If water balance is considered, rainfall, runoff, and percolation as well as evaporation are used to calculate the amount of water in the pond during each day of the simulation.

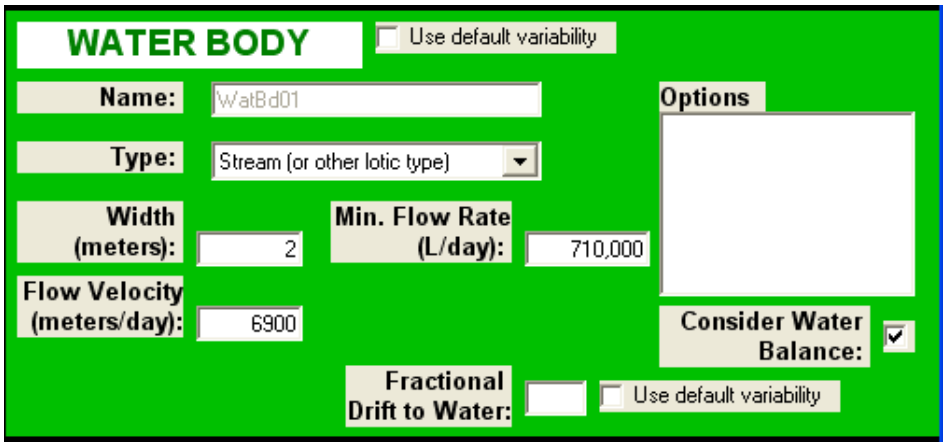
If water balance is considered, the initial depth of the pond is used simply to set the depth of the pond on the day that the simulation starts. In terms of water balance, it should be noted the day that the simulation starts is taken as January 1 of the first year in which the simulation is

conducted. Thus, if the chemical is applied on June 15 (the default for a Quick Run) or six months later on December 15 and the start year is specified as 2007, water balance would be considered starting on January 1, 2007 in both runs. Because of this approach, the initial depth of the pond that is entered in the Quick Run screen will not generally be a sensitive parameter for the concentration of the pesticide in water because the volume of the pond on the day that the pesticide is applied – i.e., the first day on which a pesticide concentration in water is estimated – will be determined largely by the rainfall and evaporation over the period from January 1 to the day the that pesticide is applied.

The entry for the minimum depth, as the name implies, sets the minimum depth of the pond. This along with the surface area of the pond is used to calculate the minimum volume of water that will be in the pond. Regardless of temperature and rainfall pattern, the volume of water in the pond is never allowed to become less than the minimum volume calculated from the minimum depth. This approach is taken to allow the user to reflect local conditions such as input streams and subsurface flows that are not explicitly considered in Gleams-Driver. The minimum depth must be a positive number. In other words, Gleams-Driver is intended for application to only permanent bodies of water and does not support the concept of a transient pond that completely dries out at various times.

4.6.2. The Stream

If you elect to model a stream, a somewhat different set of input values are available. These include the width of the stream as well as the minimum flow rate and the flow velocity.



The stream model used in Gleams-Driver is extremely simple. The assumption is made that the pesticide enters the stream at a single point from the field (e.g., a runoff ditch). Because GLEAMS uses a time-step of one day, Gleams-Driver also must use a time step of one day. The underlying assumption is that the rainfall occurs uniformly over the course of the day and that the pesticide thus enters the stream uniformly over the course of the day. This, of course, will seldom be the case and rainfall will occur sporadically over the course of the day and the consequent concentrations of the pesticide in the stream will also vary sporadically. None of this, however, will impact the average daily concentration. In terms of the use of the estimates of concentrations of the pesticide in the stream to estimate risks, the sporadic nature of the rainfall will have no effect because, as with the time steps in GLEAMS, toxicity data are most often associated with exposure durations of one day or more. Nonetheless, the user should be mindful

of this averaging process in Gleams-Driver when comparing the output from Gleams-Driver to monitoring data. Depending on when the monitoring samples are taken, monitoring results could indicate higher or lower concentrations than the average concentration reported by Gleams-Driver even if Gleams-Driver is accurately modeling the field and adjacent stream.

The width of the steam is used only to estimate deposition from drift. If the drift is set to zero, the width of the stream will have no impact on the calculation of the concentration of the pesticide in the stream.

The water body options are identical to those for the pond and are detailed in Section 4.6.4.

The minimum flow rate in liters per day is analogous to the minimum depth of the pond. As detailed in Section 7.5, the concentration in the stream is calculated simply as the pesticide loss from GLEAMS (in units of mg per day) divided by the minimum flow rate (in units of liters per day). The concentration in the stream is thus calculated base on the pesticide loss associated with rainfall divided by the total flow rate which is calculated as minimum flow rate plus the total amount of water added to the stream from runoff and/or percolation. Note that no pesticide loss will occur on days without rainfall.

Flow velocity is used only to calculate the average concentration in the stream over the distance from the point of contamination to the point downstream that is associated with the flow velocity. For example, if you accept the default of 6900 meters per day, the stream concentration represents the average concentration over an area of 6900 meters down stream from the point of contamination. As detailed in Section 7.5, this average concentration is based only on the halftime of the pesticide in water. Note that the flow velocity is assumed to be fixed. This is an obvious over-simplification. The actual flow velocity will depend on the local conditions. With substantial rainfall, the flow velocity in a real stream will increase. The flow velocity does not impact the calculation of the concentration of the pesticide in the stream (Section 7.5) but flow velocity will effect the estimate of the total length of the stream that is contaminated.

The Quick Run uses a minimum flow rate of 710,000 liters/day and a flow velocity of 6,900 meters/day. Flow rates of streams are highly variable. Many stream flow rates can be found on the USGS web site (www.usgs.gov) and Hampshire Research Institute (1995) has compiled average flow data as well as velocities of flow from USGS records on 55,701 streams as part of their Risk*Assistant program.

The minimum flow rates of 710,000 liters/day is based on data downloaded from USGS at http://nwis.waterdata.usgs.gov/usa/nwis/annual/calendar_year for streams with drainage area of 9.8 to 10 ha – i.e., 0.0380 to 0.0386 square miles. A total of 30 streams with 1712 measurements were identified. The 1712 records were sorted by annual mean flow rates, given in cubic-feet per-second. The lowest 1% value – i.e., record 17 – is 0.29 cubic-feet per-second which corresponds to 709,585.92 L/day [0.29 cu ft/sec × 28.32 L/cu ft × 60 seconds/min ×60 minutes per hour × 24 hours/day]. The lowest 5% value – i.e., record 85 – is 9.62 cu ft./sec (23,500,800 L/day). For generic modeling, the more conservative 1% value is used but is rounded to

710,000 L/day. In any more refined site-specific assessment, the user should make an effort to obtain local estimates of stream flow rates.

The USGS does not provide data on flow velocity. A rate of 0.08 meters/second is used based on data from Hampshire Research Institute (1995). This value is used to derive a flow velocity of 6912 meters/day:

$$0.08 \text{ m/sec} \times 60 \text{ sec/min} \times 60 \text{ min/h} \times 24 \text{ h/day} = 6912 \text{ m/day}.$$

The value of 6912 meters/day is rounded to 6900 meters/day on the Quick Run screen. As with stream flow rates, local values should be used when they are available.

4.6.3. Impact of Treated and Total Field Areas

As discussed in Section 4.2, the separate entries for treated field and total field area are intended to allow the user to reflect a situation where only part of a water drainage area is being treated. The size of the treated field determines the amount of pesticide as well as the amount of water that is transported to the pond or stream from the treated field. The size of the total field area is used internally by Gleams-Driver to calculate the size of the untreated area that will drain into the water body. This is turn is used to calculation the amount of water that is added to the pond or stream without any additional pesticide. Thus, the relationship of the area of the treated field to the total field area can have a substantial impact on the estimated concentrations of the pesticide in water.

For a pond, it may be relatively easy to determine the approximate total drainage area by direct examination or topographical maps. For a stream, however, the drainage from untreated areas upstream and downstream may be considered. Drainage from areas upstream of the treated site will increase the flow rate of the stream adjacent to the treated site and lower the concentration of the pesticide in the stream water adjacent to the treated site. Similarly, areas immediately downstream will also contribute to amount of water in the stream – i.e., the flow rate in L/day – and this will also decrease the concentration of the pesticide in sections of the stream that are downstream of the application site.

It is not possible to provide general guidance on the extent to which the total field area should be adjusted to account for additional water in the stream due to untreated areas that are upstream and/or downstream from the treated site. The user should be mindful that GLEAMS is a field scale and not a watershed model. Because adjusting the total field area can only decrease the concentration of the pesticide in water – i.e., make the resulting assessment of risk less conservative – the use of the total field area for estimating concentrations in streams is discouraged unless a clear rationale with reasonable limitations on the total field area can be articulated.

The best rationale for adjusting the total field area in estimating concentration in a stream could involve monitoring on the site that you area intending to model or a closely related site. If the stream concentration modeled by Gleams-Driver is substantially greater than monitored

concentrations, this could suggest that upstream or downstream drainage is impacting the analysis and an adjustment to the total field area could be justified. Note that the chemical on which this assessment is based would not necessarily need to be the chemical that you are attempting to model. In other words, you would be calibrating the behavior of the site rather than the behavior of a specific chemical.

4.6.4. Water Body Options

By default, Gleams-Driver takes daily losses from that filed that are modeled by GLEAMS and assumes that these losses go directly to the water body on the same day that they are lost from the field. These losses include the volume of water in percolate and runoff as well as the mass of the chemical in percolate, runoff, and sediment. If you are doing a standard Quick Run in which the entire field is being treated – i.e., the treated field area is equal to the total field area as discussed in Section 4.6.3. – this is a conservative assumption and you may want to leave the water body options box blank.

The assumption of instantaneous transport from the field to the water body, however, is not realistic, especially for large areas. This is particularly true for percolation. If you are treating a large field, percolate from the section of the field that is immediately adjacent to the water body may reach the water body very quickly. Percolate from more distant sections of the field, however, will take longer to reach the water body.

To account for this type of behavior, Gleams-Driver allows you to define three virtual reservoirs

Perc: designating the percolate loss (water and chemical) from the field

Runo: designating the runoff (water and chemical) loss from the field

Sedi: designating the sediment (mass of sediment and chemical) loss from the field.

For each of these reservoirs, you can specify four parameters:

MediaLossRate: the first-order rate constant for loss of the water or sediment from the reservoir to the water body in units of day^{-1}

ChemLossRate: the first-order rate constant for loss of the chemical from the reservoir to the water body in units of day^{-1}

ChemDegRate: the first-order rate constant for degradation of the chemical in the reservoir in units of day^{-1}

PropLost: the proportion of loss from the field to the reservoir

A specific value for a specific reservoir is designated by concatenating the reservoir code with the parameter code. For example, **PercMediaLossRate** designates the rate constant for loss of percolation water from the virtual reservoir to the body of water.

The values for each parameter are indicated by an equal sign following the parameter code and then the value itself. For example, **PercMediaLossRate = 0.05** would indicate a first order loss rate of 0.05 day^{-1} for percolation water from the virtual reservoir to the body of water. The values for any of the parameters can be specified as a distribution. For example, **PercMediaLossRate = Uniform(0.05 0.1)** would indicate that the first order loss rate for percolate water has a uniform distribution with a range of 0.05 day^{-1} to 0.1 day^{-1}.

If you specify more than one parameter, the parameters must be delimited by commas as in the following example:

PercMediaLossRate = 0.05, PercPropLost = 0.9.

In a Quick Run, the above expression would be entered into the **Waterbodies** data table of the Access data base created by the Quick Run for the **ValueCode** of **InpField** as:

Site01[PercMediaLossRate = 0.05, PercPropLost = 0.9].

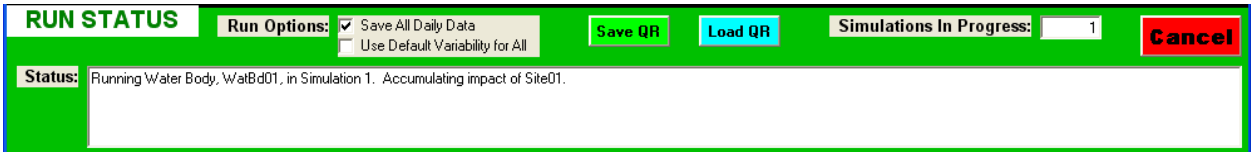
Internally, Gleams-Driver will take each loss from the site on each day and add this loss to the reservoir. If a **PropLost** parameter is specified, the daily loss from the site will be multiplied by the **PropLost** parameter before the daily loss is added to the reservoir. The amount of material (water or chemical) going to the body of water is then calculated as the product of the amount in the reservoir and the **MediaLossRate** for the reservoir. Once this loss is added to the water body, the same amount is subtracted from the amount remaining in the reservoir. If a **ChemDegRate** is specified for the reservoir, the amount remaining in the reservoir is reduced by the **ChemDegRate**. This process is repeated each day.

It is the responsibility of the user to justify the application of reservoirs. In general, the application of reservoirs should be reserved for applications in which you are calibrating the model to monitoring data or have an existing analysis for a similar water body that justifies the use of the reservoir.

Preliminary testing of the reservoirs implemented in Gleams-Driver indicates that the reservoir for percolation can be useful in properly modeling the dynamics of stream flow and pond volume. The reservoirs for runoff and sediment loss could be used to emulate a buffer. This capability, however, has not been evaluated to date in the development of Gleams-Driver.

4.7. Run Status

The bottom part of the Quick Run screen specifies information on the status of the run, contains buttons to both start and stop the run as well as buttons to save or load a Quick Run Screen, and offers two run options: Save All Data and Use Default Variability for All.



4.7.1. Starting and Stopping the Quick Run

The simulation is initiated by activating the **Run button,** 

. Once this is done, the Simulations in Progress text label and text box will appear and the **Run button** will change to a **Cancel button**, illustrated above. If you press the Cancel button, the run will terminate but only after the current simulation is completed.

4.7.2. Saving and Loading a Quick Run

At any time while you are setting up the Quick Run, you can press the **Save QR** button. The save file selection dialogue box will then open and you will be prompted to enter the name of the file that you want to use to save the Quick Run Screen. The default name is **`Save Of Quick Run.txt`** but you should probably change this to something more meaningful to you. Then press the "Save" button in the file selection dialogue box. If the file that you have specified exists, you will be asked whether or not you want to overwrite the existing file.

Once the name of the file has been accepted and you press the "Save" button, an standard ASCII text file will be created in the location that you specify. This file will contain the complete state of the Quick Run screen, including information on all soil layers and options. An example of a Quick Run Save file is given in Appendix 4.

A saved Quick Run file can be reloaded by activating the **Load QR** button. This will change the current Quick Run screen to the conditions (i.e., values and all options) that existed when the Quick Run Save file was created.

Note that you cannot "Load" an Access input database from the Quick Run screen. Conceptually, the Quick Run screen is intended to be a user-friendly interface between the detailed information in the various Access databases in the **`SupportFiles`** subdirectory – i.e., information on the chemicals, locations, and soil – and the information that is required to run GLEAMS. The Access input database that is created by the Quick Run screen, however, is independent of the chemical and soils databases and may contain much more elaborate information – i.e., multiple chemicals, sites, soils etc – all of which may be edited by the user in the Full Run utility or directly in Microsoft Access. Thus, if you want to run or edit the Access

input database that is created by the Quick Run screen, you must use the Full Run screen.

4.7.3. Saving All Data

The **Save Intermediate Data** option determines which output files and intermediate data are stored. When you start a run, the Gleams-Driver program creates three subdirectories in the directory where you create the driver file. These subdirectories are:

```
Access Files
Gleams Output Files
Gleams Input Files
```

If the **Save Intermediate Data** box is checked, all input files and output files from GLEAMS are saved in the appropriate subdirectories. The files are renamed to indicate each simulation. The **`Access Files`** subdirectory will contain only a single Access database, whether or not the button is checked. If the button is checked, however, the Access database will contain data tables for each site that is modeled (treated site, nontarget field, and nontarget water body) for each simulation that is conducted.

If you are reviewing/auditing the Gleams-Driver program to determine that the GLEAMS input files are correct and that the output files are correctly read and manipulated, you will be doing a small number of runs. In this case, saving all intermediate data is necessary. On the other hand, if you a doing a Monte Carlo analysis or even running a modestly large number of simulations (e.g. 100) to look at the impact of rainfall patterns, keeping the **Save Intermediate Data** box checked will lead to a very large number of files and a very large Access database.

4.7.4. Default Variability

Just below the **Save All Data** box is another check box labeled **Use Default Variability for All**. As noted in previous subsections, users can elect to use default variability for information specific to the application, soil, water body, and drift. **Use Default Variability for All** check can be used to control all of these options. When the Quick Run screen is opened, the Quick Run screen is set to not use default variability. Thus, all of the individual check boxes are unchecked and the global **Use Default Variability for All** check box is also unchecked. If you check the **Use Default Variability for All** check box, the individual **Use default variability** boxes will all be checked. Similarly, rechecking the **Use Default Variability for All** check box will turn off (uncheck) all of the individual **Use default variability** check boxes. If you manually check some but not all of the individual **Use default variability** check boxes, the **Use Default Variability for All** check box will appear checked but dimmed. Selecting the **Use Default Variability for All** check box in the dimmed state will clear (uncheck) the **Use Default Variability for All** check box as well as all of the individual **Use default variability** check boxes.

The global **Use Default Variability for All** check box was added as tool to ensure that users are aware of what default variability assumptions will be used in the run. The decision of whether or not to use default variability is one that the user must make depending on their preferences and

approach to Monte Carlo analyses. A position can be taken that Monte Carlo analyses should not be used unless the distributions of the variables are known. In this case, the user would probably elect not to consider default variability. A more liberal position on Monte Carlo analyses could assert that many if not all of the inputs into GLEAMS will never be known with certainty but will most certainly be variable. For example, if you are attempting to model a particular field, you could measure soil porosity (or any other input parameter) and you would get a range of results reflecting some combination of random error in the measurements as well as nonrandom but real differences in porosity in different parts of the field. With these considerations, the user might elect to use default variability simply to reflect some underlying variability in the input parameters. If the user had information on variability this would not be well reflected with the default approach in the Quick Run, the output file from the Quick Run could be used to input more appropriate distributions in a Full Run (Section 5.4).

4.7.5. Run Completion and Output

When the run is completed, you will hear a beep and the tips box will indicate that the run is done. The Cancel button will revert to the run button and simulation progress box will not be visible. As summary of the run results will also be opened in a separate window.

The detailed results of the run will be stored in an MS Access output database that has the name that you specified at the top of the Quick Run screen (Section 4.1). The output files that are generated by Gleams-Driver are similar in both a Quick Run and a Full Run and are described in Section 8 (Reports and Databases).

4.8. GLEAMS and Gleams-Driver Runs

As noted in Section 1, GLEAMS is a DOS program. Gleams-Driver runs GLEAMS in what is called a *DOS Shell*. When you press the Run button, the input Access data base is made and you are given the option of continuing with the run or exiting back to the Quick Run screen.

If you continue with the run, GLEAMS will open in a plain text DOS window and, when the single GLEAMS run is complete, the DOS window will automatically close. This will typically be a very fast process.

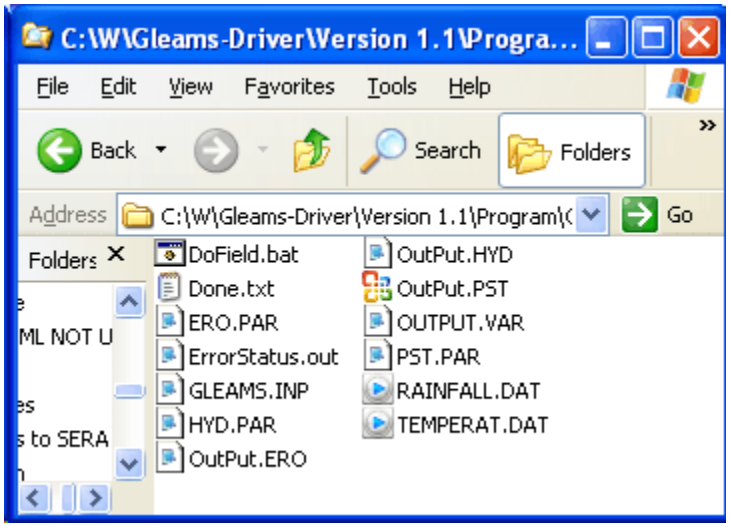
Once the DOS window for GLEAMS closes, there will be a longer period while the Gleams-Driver does post-processing. The post-processing involves reading the GLEAMS daily output file, transferring the information to Access databases, and then applying the post-processing algorithms (Section 7). During this period, the Tips area of the Quick Run screen (Section 4.7) will display the status of the run indicating what is being done. In addition, a graphic progress screen will be displayed. The graphic progress screen (currently an eagle preying on a fish) is intended only as a visual indicator that the program is running. This progress window can be closed at any time during the run and will not impact the progress of the run.

If you are doing a Quick Run, you should never have a GLEAMS run end with an error. This could occur, however, because of an improperly formatted driver file in a Full Run or due to a bug in the programming for a Quick Run.

If there is an error in a GLEAMS run, the DOS window will remain open and you will see the word **PAUSE** followed by the phrase **Press any key to continue . . .**, near the bottom of the DOS window. This is illustrated in Figure 4.

PAUSE is a standard DOS command that stops the execution of a bat file, the type of file used by Gleams-Driver to run GLEAMS. **Your computer is not frozen**. The DOS **PAUSE** command is used in the bat file to give you an opportunity to look at the DOS screen to determine what went wrong. In the example given in Figure 5, the dashed red line highlights the area of the DOS screen where useful information might be found. In this example, the error was intentionally caused by deleting a necessary input file, **PST.PAR**. Note that the error message reads **"file not found,"** and goes on to indicate that **PST.PAR** is the name of the missing file.

Once you have obtained any useful information, press any character key on the keyboard and you will be at the standard DOS prompt. This is illustrated in the area below the dashed yellow line in Figure 5. At this point, type in the word **exit** and the DOS window will close. You should then look at the error file, **Errors in GLEAMS Driver Run.txt**. This file may have other error messages generated from the Gleams-Driver program that may help you to correct the error.



As noted in Section 2.3 (Post-Installation), the **GLEAMS Working Directory** is created by the installation program immediately below the directory where Gleams-Driver is installed. Right after installation, this directory contains only one file, **GLEAMS3.EXE**. After each run, however, a number of different files will be in the **GLEAMS Working Directory**. These are illustrated in the figure to the right. After a successful run, these files are moved from the **GLEAMS Working Directory** to the **Last Run** directory that is created by Gleams-Driver in the **GLEAMS Working Directory**. If you experience problems or suspect problems in a Gleams-Driver run these files can be moved or copied to the **GLEAMS Working Directory** and you can re-run GLEAMS at the DOS prompt by executing the **DoField.bat** bat file.

4.9. Runtime Errors

Runtime errors are untoward events that are not handled by the Gleams-Driver program but are detected by the operating system. Runtime errors indicate a programming error at least to the extent that the error was not detected and properly handled by the Gleams-Driver program. The runtime errors themselves can be caused by programming errors or data input errors. A substantial effort has been made to prevent data input errors by including additional checks to the input data and by imposing constraints on some of the model parameters (Section 4.3). Some additional effort has been made in trapping other general errors that are not specifically handled by Gleams-Driver. Nonetheless, runtime errors may occur from time to time.

A runtime error will be indicated by a very plain gray error window indicating that an error has occurred. Typically, there will be both an error number and a rather cryptic error message.

Occasionally, the error message can be used to determine why the error occurred and you may be able to correct the error – e.g., a missing file. More often than not, however, the text of the error message may have little meaning – e.g., an unhandled exception in a DLL or an access violation.

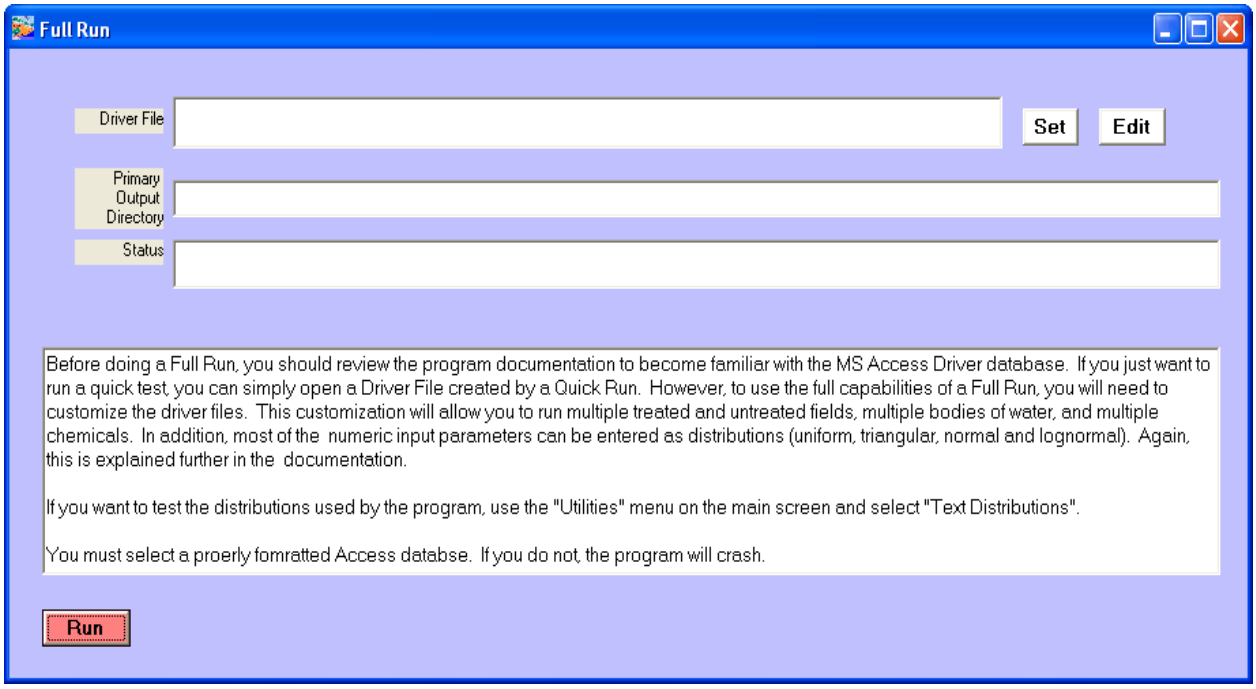
If you get a runtime error, it would be helpful if you would note the error number and error message. An even better approach is to make a screen shot of the error message.

In terms of your PC, the runtime error will do no real damage. However, in a runtime error, the program just stops and memory used by the program may not be properly released back to the operating system. Thus, if you get a runtime error, it is a good idea to close any open programs and reboot your computer. This will free any memory that the stopped program may still be using. This procedure applies to runtime errors in any program.

5. Full Run

5.1. Overview

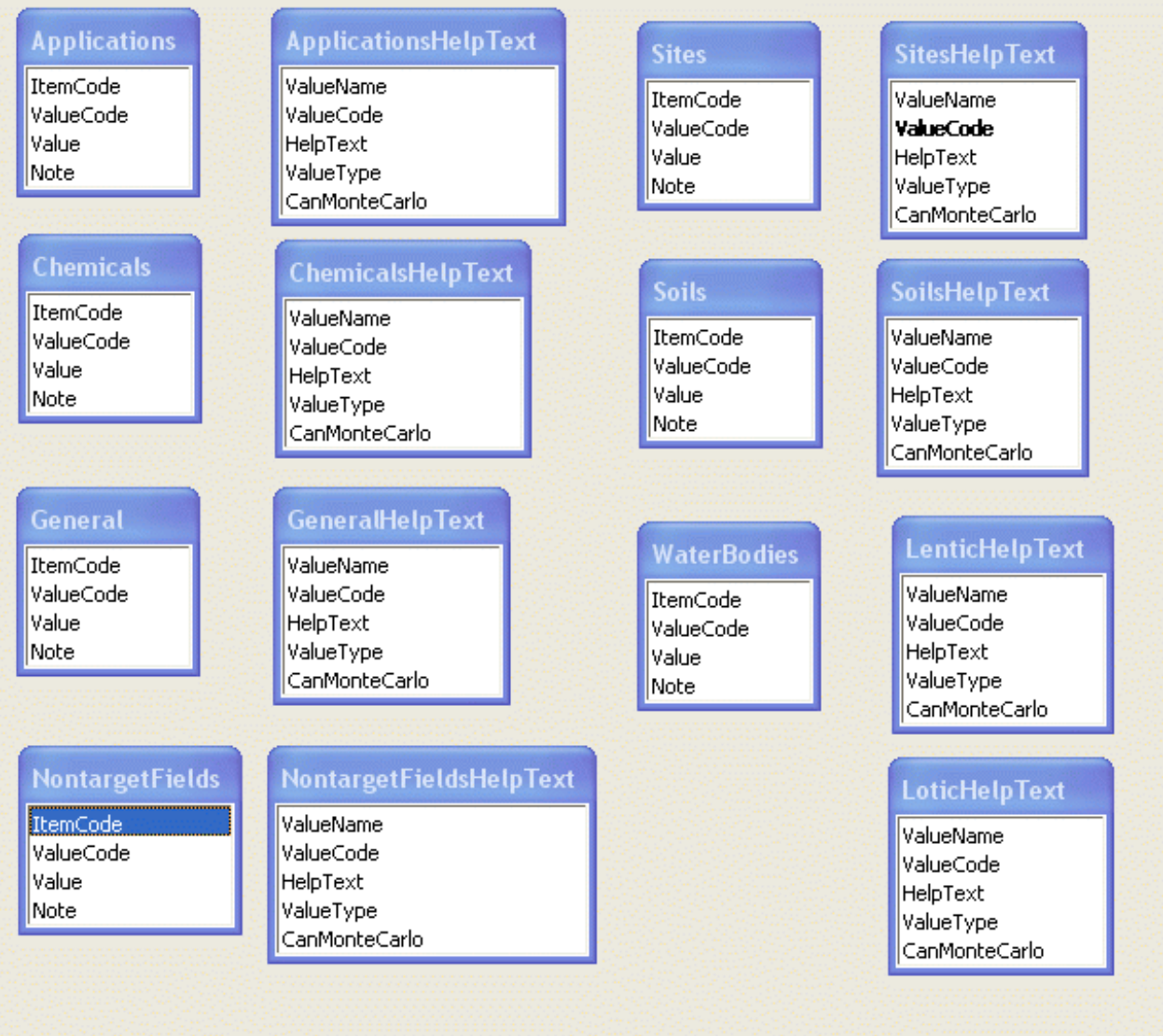
A **Full Run** is designed to be used by individuals who are familiar with GLEAMS as well as environmental fate and simulation modeling. As illustrated in Figure 5 (and embedded below), the Full Run window has very few options. Similar to a Quick Run, you must select a driver file using the **SET** button. Unlike the Quick Run, however, the driver file must exist. The Full Run window cannot be used to create an MS Access driver file.



As noted in Section 4.7, the Quick Run utility creates a driver file that can be used in a Full Run. The Quick Run driver file is a relatively simple. In doing a Full Run, the recommended approach is to first do a Quick Run with conditions that are close to those that you want to use in Full Run. Then, exit the Quick Run without actually doing the run and open the input Access database in the Full Run screen. As with the Quick Run, the Full Run window has a **Run** button that is used to actually do the Gleams-Driver simulation. Pressing the **Run** button will trigger a series of GLEAMS runs and post-processing that are identical to those done in a Quick Run.

Also as in the Quick Run, **Gleams-Driver Help** is available by pressing the Help Key (F1) but the help features in the Full Run are less well developed than in the Quick Run.

The power of a Full Run is in the ability to edit the Access driver data base. The structure of this database is illustrated in Figure 6 (and is embedded at the top of the following page). The database consists of seven basic data tables. [Note: In database jargon, a database is a set of one or more tables. The database, at least in MS Access, is a single file that contains data tables as well as other features beyond the scope of this discussion.]



As noted in Section 4.7, these seven data tables contain general information, site information, soil information, chemical information, application information, and information on one or more nontarget sites and bodies of water. In addition to these data tables, the data base contains eight **Help Text** tables. With the exception of the two help tables for different types of bodies of water (ponds and streams), each **Help Text** corresponds to a data table and contains help information on the data table.

Each of data tables consists of four columns: **`ItemCode, ValueCode, Value`**, and **`Note`**. In database jargon, these are referred to as fields. The **`ItemCode`** contains a short term that is unique to the item to which the other fields apply. For example, the Quick Run always refers to the body of water with an **`ItemCode`** of **WatBod01**. If another body of water is added in a Full Run, a different code (e.g., **Pond02** or **Stream02**) would be needed.

The **ValueCode** is a code for the type of information. For example, every pond must have an initial depth and this has a value code of **Depth0**. Note that upper case strings used for a **ValueCode** correspond to the nomenclature and codes used in the GLEAMS documentation (Knisel and Davis 2000). The mixed case codes in the **ValueCode** field are codes unique to Gleams-Driver and are most often associated with information needed by the post-processing algorithms (Section 7).

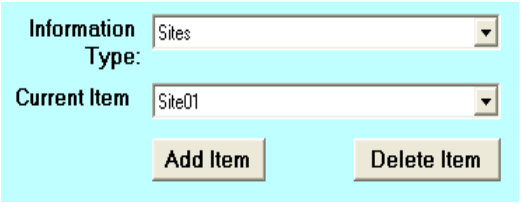
The **Value**, as the name implies, is simply the value that corresponds to the **ValueCode** for the **ItemCode**. Because some values are strings (e.g., names) and some numeric values can be entered as distributions, all **Value** fields are represented in the data tables as string fields.

The **Note** column is a text field (i.e., a memo field) in which the user can enter documentation for the value.

The **Help Text** tables provide detailed plain language descriptions for all **ValueCode** entries that apply to the seven types of data tables – i.e., general information, site information, soil information, chemical information, application information, nontarget sites, and bodies of water (ponds or streams).

5.2. Designating Multiple Chemicals, Sites, and other Variables

A major difference between a Full Run and a Quick Run is the ability to consider multiple treated and untreated sites, bodies of water, chemicals, and applications. While an input database can be constructed using MS Access directly, a simpler and less error prone method is to use the **Edit** feature of the Full Run window. As illustrated in Figure 5, the Edit button in Full Run window is directly to the right of the Set button. Once you have opened an existing input database, you can activate the Edit button and this will open the **Full Run Edit window**, which is illustrated in Figure 7.

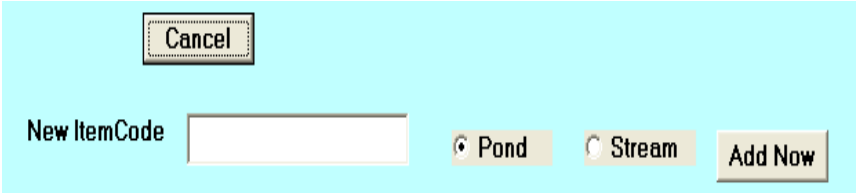


The top part of the **Full Run Edit** window allows you to select the type of information that you want to edit. The types of information correspond to the seven data tables: general information, site information, soil information, chemical information, application information, and information on one or more nontarget sites and bodies of water. These types of information can be selected using the upper combo box (i.e., labeled *Information Type*). If you have already defined more than one item for a particular type of information, another combo box will be visible immediately below the Information Type combo box. This second combo box will allow you to select the particular item that you want to edit (e.g., Site 01 or Site 02).

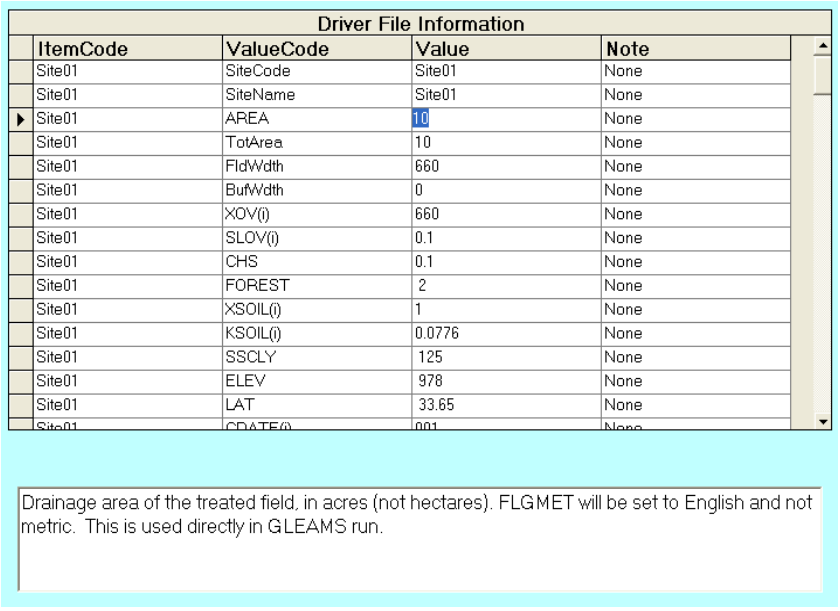
Except for the General Information type, buttons below the Current Item combo box will allow you to add or delete items.

To delete an item, simply select the item in the Current Item combo box box and press the **Delete**

Item button. You will be asked to confirm the deletion and, if you do so, all information on the item is deleted from the underlying database. Note that you cannot delete an item unless there is more than one item already defined in the database.



To add an item, press the **Add Item** button. Once you do this, the display will change. The caption on the **Add Item** button will change to **Cancel** and an **Add Now** button will appear to the right (see illustration above). At any time before you press the **Add Now** button, you can press the Cancel button and this will cancel the procedure. A text bow will also appear where you will need to enter a **New ItemCode**. As discussed above, this item code must be unique – i.e., not already used in the database. If the information type is a body of water, radio button will appear to the right of the **New ItemCode** box and you will need to specify whether you are adding a **Pond** (i.e., any lentic water body such as a pond or lake) or a **Stream** (i.e., any lotic water body such as a stream, creek, or river). Pressing the **Add Now** button will physically add an appropriate set of records to the underlying data table. Note that all **`Value`** fields are filled with the following string: **`#@!%$`**. This is intended to make it easier for you to identify which values need to be filled in.



The bottom part of the **Full Run Edit** window contains two areas: the larger area is a grid of the underlying records in the data table and a smaller area of help text for the active record (i.e., row) in the grid.

You can move from row to row using the mouse cursor or the up and down arrow keys.

Note that you cannot position the cursor on either the first column (**ItemCode**) or second column (**ValueCode**). These are filled in automatically by the program. You can and should edit the **Value** and **Note** columns. Guidance for entering information into the **Value** column will be in the help text box below the data grid and the help text will change as you change rows.

Note that some of the different data tables need to have linked entries. Specifically, each site table must be linked to a soil. The following row is near the bottom of the site data table:

Soil Link	SoilLink	**SOIL01**	This is the code for a soil that is defined in a soil sub-driver file – e.g., SOIL01. The name must correspond to the soil code that is given in a table in the soil sub-driver file. See the discussion in Section 5 of the documentation for Gleams-Driver.

You must enter a code in the value column that would correspond to a code that you designate in the soil sub-driver table. In the third row of a soil data table, you will find the following:

Soil Code	Code	**SOIL01**	Short code for linking the soil to the field. In a Quick Run, this is always set by the Quick Run module to **SOIL01** and this soil is linked to **SITE01**. In a full run, this code can be anything meaningful to the user but it must be linked to the appropriate site – i.e., field.

Thus, if this table describes the soil at the particular site, then the soil code that you enter – e.g., **SOIL01** – would be entered in the value column of SoilLink row in the site table.

This approach may seem somewhat circuitous. Several different designs were explored. The approach that has been adopted allows you to minimize the number of data tables that are needed. In the site/soil example, the same soil can be linked to more than one site.

There are similar links needed for application data table and chemical data table. Each application must involve a designated chemical code (i.e., the chemical that is being applied) as well as a designated site code (i.e., where the application is occurring):

Chemical Code	**PSTNAM**		This must correspond to the short name (PSTNAM, up to 16 characters) used in GLEAMS files as specified in a chemical file.
Site Code	**SiteCode**		The site/field where the application is made. This must correspond to the **SiteCode** in one of the **Site Information** tables that are included in the driver file.

The codes that are entered here in the value column must correspond to codes that entered in the site and chemical data tables.

5.3. Control of Output Variables

Another advantage of a Full Run over a Quick Run involves the control of output variables. A Quick Run provides a fixed-set of output variables: concentrations in the top 1 foot and top 5 feet of soil, peak offsite application rate for the offsite field, and peak as well as annual water concentrations in nontarget bodies of water (ponds or steams). As noted in the various data tables, you can fill in as many output variables as you want giving concentrations over differing soil depths or time-weighted average concentrations for different periods of time. Note that increasing the number output values will increase the time required for computation.

5.5. Monte Carlo Simulations

The last major difference between a Full Run and a Quick Run involves Monte Carlo simulations. If the check boxes for Use Default Variability are all unchecked, doing multiple simulations in a Quick Run will lead to differences in results based only on differences in rainfall, temperature, and other climate factors. These differences are based on weather simulations from Cligen (Section 6.1). If you enable (check) the Use Default Variability check boxes in Quick Run Screen, you will enable Monte Carlo simulation for many important variables but the default variability – i.e.,a triangular distribution in which the mode is the taken the default value, the lower limit is 0.5 of the mode and the upper limit is twice the mode – may not be what you want to use.

In a Full Run, however, you can enter the value for most model parameters as a distribution. You get to select the type of distribution – i.e., normal, log normal, triangular, or uniform – and specify the parameters for the distribution. The syntax for doing this is detailed in Section 6.3.

Not all numeric parameters can be subject to Monte Carlo analysis and guidance on this will be given in the help text of the data table. Internally, the use of distributions is controlled so that most values are allowed to vary from run-to-run rather than day-to-day. This is generally what you would want. For example, while there may be uncertainty in a Koc for a particular compound, it would make little sense to allow the Koc to vary with each day. If the Koc is entered as a distribution, it is only allowed to vary from run-to-run.

It is beyond the scope of this documentation to discuss the proper design and conduct of Monte Carlo simulations. There is a rich literature on Monte Carlo methods and their application to probabilistic risk assessments. If you are doing a Full Run and want to use Monte Carlo simulations, you should be reasonably familiar with this literature. Nonetheless, it should be noted that Gleams-Driver provides empirical confidence intervals. In other words, if you do 20 simulations, the lowest empirical bound that you can get is 0.05 (1/20). In general, this minimal number of runs would not result in stable confidence intervals – i.e., if you did the run again with a different weather offset and a different random number seed, the empirical confidence interval would change and could change remarkably. One indication that you may be doing a sufficient number of runs to properly estimate the variability is stability in the empirical limits among different sets of simulations. As an alternative, you can conduct your own statistical analyses on the individual simulations using any number of statistical software packages.

5.6. Information Sources for Full Runs

The major point of the Full capability of Gleams-Driver is to allow to greater control over the simulation and the incorporation of greater information into the simulation. While there are many sources that can be used to obtain site, soil, and chemical information, three sources of information have been used in the development and evaluation of Gleams-Driver and may be generally useful to others:

- **USDA/ARS Pesticide Properties Database** (http://www.ars.usda.gov/Services/docs.htm? docid=14199),
- **USDA/NRCS Web Soil Survey** (http://websoilsurvey.nrcs.usda.gov/app/),
- **USGS National Water Information System** (http://waterdata.usgs.gov/nwis).

The **USDA/ARS Pesticide Properties Database** was developed and is maintained by the USDA's Agricultural Research Service (USDA/ARS), Crop Systems and Global Change Laboratory in Beltsville, Maryland. This database contains information useful to environmental modeling on 334 pesticides. In addition to providing recommended values for chemical properties such as soil half-lives and K_{oc}, this data base will often a number of different values for key chemical input parameters. These values can be used to define distributions for Monte Carlo analyses and/or to select values that might be more representative of a particular type of soil texture.

The **USDA Web Soil Survey** is an online program developed by the USDA's Natural Resources Conservation Service (USDA/NRCS). This program provides an interface to a database system containing soil maps and data on more than 95 percent of the counties in the United States. Detailed directions for using this tool are available at the web site, http://websoilsurvey.nrcs.usda.gov/app/. Essentially, the user must specify a general location. This can be done in a number ways including specifying the latitude and longitude. The next step involves defining what is called an Area of Interest. In terms of Gleams-Driver, this would be the treated field or the drainage area for a body of water. Once this is done, a Soil Map and Soil Data Explorer utility can be used to obtain site-specific data on both the site (the location and distribution of soil types and field slopes) as well many of the specific input parameters that are required by Gleams-Driver. [Note: While this program is very user-friendly, it is highly graphical and appears to involve a great deal of database manipulation. Even with a fast internet connection, the program can sometimes appear to freeze. Experience to date using this program suggests that the program is not actually frozen but simply that a great deal of information is being manipulated and transferred. The information is well-worth the wait.]

The USGS **National Water Information System** is a web resource that contains a great variety water-resources data for about 1.5 million sites throughout the United States and Puerto Rico. In terms of Gleams-Driver, the most relevant type of information involves monitoring data on lake volumes and stream flow rates. The information from USGS National Water Information System can be used directly as a source of information on stream flow rates or lake depths. More importantly, this web site provides time series data on both lake volumes and stream flow rates that can be used to calibrate the percolation reservoir in Gleams-Driver (Section 4.6.4).

The **National Water Information System** web site is largely form-driven – i.e., you specify the water body based on criteria that is entered into a web form. The outputs from this web site that are most relevant to the use of Gleams-Driver consist of text files giving monthly or daily statistics on water volume or stream flow. To facilitate the use of this very important resource, EXCEL utilities have been developed convert the text files from this web site to EXCEL workbooks that can be used to assess the calibration of the percolation reservoir in Gleams-Driver to a specific site.

6. Gleams-Driver UTILITIES

All of the utilities in Gleams-Driver can be accessed by activating the Utilities menu on the main screen. Each of the utilities are discussed in the following subsections.

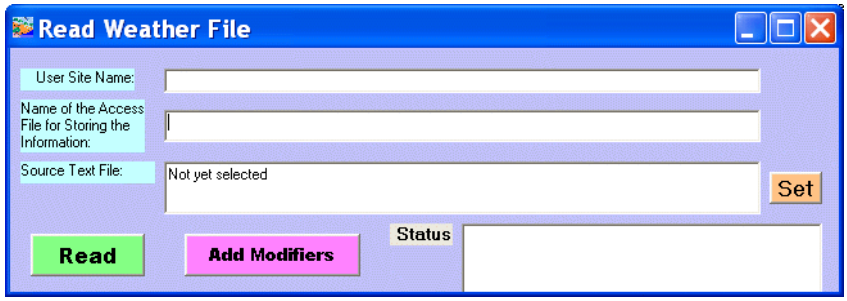
6.1. Location/Weather Files

6.1.1. Using the Gleams-Driver Conversion Utility

As discussed in Section 4, the locations that are available during a Gleams-Driver run depend on the location/weather Access databases that are in the **`\SupportFiles\Locations`** subdirectory under the directory where Gleams-Driver is installed.

Weather files can be imported from text files that are created from Cligen Version 4.3 or Cligen Version 5.2. This import utility can be activated from the main screen of Gleams-Driver (Figure 2) by selecting the **Utilities** menu item and then selecting **Import Weather Files**. This will open the **Read Weather File** form as illustrated in Figure 8.

Cligen files can be imported either simply or with modification. The simple import form is illustrated at the top of Figure 8 and is reproduced in the figure to the right of this paragraph.



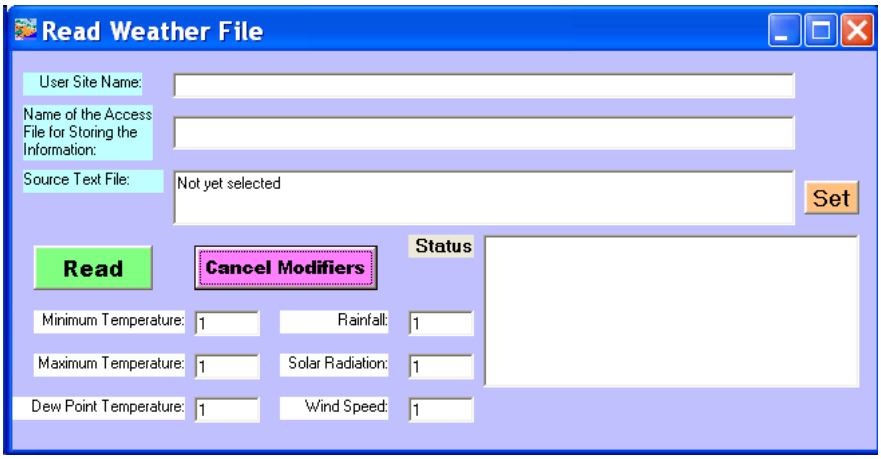
This is a very simple form. You need to fill in a descriptive name for the site as well as the name of the Access database that you want to create. The descriptive name can be anything meaningful to you. This name is not otherwise used in the program. The Access database file name must be a file name that follows Windows naming conventions.

Then, using the **Set** button, you must identify the location and name of the text file from Cligen that you want to convert. Pressing the **Set** button will bring up the standard file selection box discussed and illustrated in Section 4.1. By default, the filter on the **Set** button is **`*.cli`**. This is the extension that is used by Cligen to name the weather files. The dropdown list on the file selection box can be used to change the files that are displayed to either **`*.txt`** (files ending with the txt extension) or **`*.*`** (all files). You will need to use this feature only if you have

renamed the Cligen output files.

Note that the **Read Weather File** form also has an **Add Modifiers** button. Activating this button will enlarge the **Read Weather File** form as illustrated in bottom of Figure 8 and reproduced at the top of the following page.

The enlarged form provides you with six fields that allow you to enter multiplicative factors that are used to adjust the values from Cligen for all of the climate values that are used by Gleams-Driver: minimum temperature, maximum temperature, dew point, rainfall, solar radiation, and wind speed.



Cligen simulations are based on past weather patterns. The adjustment feature for the Cligen files has been added to allow the user to make adjustments to the weather variables to approximate weather conditions at locations that are not explicitly covered by Cligen or to conduct the Gleams-Driver simulation based on anticipated or projected changes in future weather patterns – e.g., warmer or cooler temperatures or anticipated increases or decreases in rainfall, wind speed, or solar radiation.

All adjustment factors are multiplicative – i.e., the factor that you entered is multiplied by the value produced by Cligen. No checks on the adjustment factors are made by this utility. It is the responsibility of the user to ensure that any differences in the factors are reasonable in terms of their magnitude and interrelationships. For example, entering a factor a 2 in the minimum temperature field would multiply all of the minimum temperatures read from the Cligen file by a factor or 2. This would never be reasonable. In addition, the resulting adjusted minimum temperatures would probably often exceed the maximum temperature unless the same adjustment factor was used for the maximum temperature. Again, it is the responsibility of the user to ensure that any and all adjustments are reasonable and that related adjustment factors are properly set.

When the an **Add Modifiers** button is activated, the text on the button changes to **Cancel Modifiers**. Pressing this button collapse the window to it's original state and will reset all of modifiers to 1.0.

After the Cligen text file is identified and any modifiers have been set, activate the **Read** button in the lower left side of the **Read Weather File** form. The text file will be read into a properly

formatted Access database that can be used by the Gleams-Driver program. The database will be located in the same directory as the Cligen source file.

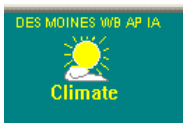
In order to use this database, you must copy or move the database to the **\SupportFiles\Locations** subdirectory and then refresh the listing of available databases in Gleams-Driver. The process of refreshing the databases is detailed in Section 6.2.

Note that the Gleams-Driver program expects that the **\SupportFiles\Locations** subdirectory will contain only Access files that are properly formatted as weather files using the utility described in the section. You should not place any other types of Access database files (i.e., ***.mdb**) such as input or output databases for Gleams-Driver in the **\SupportFiles\Locations** subdirectory. If you do so, the non-weather Access files will not be recognized. This will generate a warning message but not an error message.

6.1.2. Getting Cligen Files

Obtaining Cligen weather files will require that you obtain a copy of Cligen Version 4.3 or Cligen Version 5.2. Cligen is a climate generator program that was developed and is maintained by the USDA Agricultural Research Service. Cligen can be downloaded from the following web site: http://horizon.nserl.purdue.edu/Cligen/. Instructions for using Cligen are also available at this web site.

Like GLEAMS, Cligen is a DOS based program. As an alternative to using Cligen directly, users may want to consider using WEPP (Water Erosion Prediction Project) (Flanagan and Nearing1995). WEPP is a windows based program, also developed by USDA/ARS, that offers a very user-friendly interface to Cligen Version 4.3 and Cligen Version 5.2. WEPP can download from the following web site: http://topsoil.nserl.purdue.edu/nserlweb/weppmain/.



The opening screen in WEPP is illustrated in Figure 9. To get to the Cligen interface, you can accept the default selection by activating the start task button (marked with a dashed red line in Figure 9). This will close the **Welcome to WEPP for Windows** and leave the main window open. When this window closes, use the mouse and **double-click** on the Climate symbol (marked with a solid red line in Figure 9 and illustrated here to the right of the page) for the default location of Des Moines, Iowa.

When this is done, the **Climate: weppdomo.cli window** will open (Figure 10). In this window, you can select the State and the weather station for which you want to generate a Cligen weather file and you can specify the version of Cligen that you want to used – i.e., either Version 4.3 or Version 5.2. If you select Cligen Version 5.2, you can also enter a random number seed. The random number seed acts in a manner similar to the specification of the random number seed in Gleams-Driver (Section 4.2). In general, you should specify the random number seed and record the value that you have used. This value is also recorded in the Cligen output file. This will allow others to duplicate your simulation.

You can also specify the number of years that you want to generate and the starting year. For use in Gleams-Driver, always leave the starting year set to 1, the default value. Also, leave the "Use English Units" box checked (again the default). This is what the Gleams-Driver utility expects. Currently, the Gleams-Driver utility does no error checking on units in the Cligen text file.

Cligen does have a very convenient Map facility that allows you to graphically navigate to a specific location in the continental United States and select the location for which a climate file should be simulated by latitude and longitude. In addition, the Map feature offers the capability of selecting the nearest weather station or interpolating values based on a set of nearby weather stations. **You should exercise great care to ensure that the weather values generated by Cligen reflect the weather patters that occur or are likely to occur at the site you are modeling.** This can be very important in mountainous areas where the weather patterns at a nearby site in a low-lying region can be very different from the weather patterns at higher elevations.

Once this form is set, use the mouse to activate the **Save As** button. Save the file with any name you want to the directory that WEPP selects. Do not try to change directories at this point. Once this is done, you can copy the text file to the directory that you want to use to generate the Access file for Gleams-Driver and follow the instructions given in Section 6.1.1.

6.2. Refresh Locations Database

Similar to the utility for importing Cligen weather files, the **Refresh Databases** utility is available from the main screen of Gleams-Driver (Figure 2) by selecting the **Utilities** menu item and then selecting the **Refresh Chemical and Sites Databases** option.

There is no real interface (i.e., form or window) for this utility. When you refresh the databases, however, a pink window similar to Figure 1 will open and the top part of the window will indicate that the databases are being refreshed. The bottom part of the window will indicate the file that is being processed. When Gleams-Driver is first started, the databases are automatically refreshed. On fast PCs, this process occurs very quickly and you might simply see a pink flicker on the screen.

All that this utility does is examine the **`Locations Available.mdb`** in the **`\SupportFiles`** subdirectory of the main directory for Gleams-Driver. If the **`Locations Available.mdb`** database is missing, the database is created. If the **`Locations Available.mdb`** database is in the directory, all entries are erased and the files that are in the **`\SupportFiles\Locations`** subdirectory are read.

Thus, as noted in Section 6.1, you must put any new Access database generated from the Cligen utility into the **`\SupportFiles\Locations`** subdirectory. Once this is done, then you can just run the **Refresh Databases** utility as described earlier in this section.

6.3. Adding and Deleting Chemicals

The **Add/Delete Chemicals** option can be accessed from the Utilities Menu of the Main Window. The **Add or Delete Chemical** form is illustrated in Figure 11. To add a chemical, you must prepare a simple ASCII text file in which the standard fields **ValueCode**, **Value**, and **Note** are separated by ampersand (**&**) symbols.

The first line of the text file must contain the ***Desc*** value code. This code is used to uniquely identify the chemical and is used to set the **ItemCode** for all of the entries for the new chemical. For example, for a new chemical that you want to refer to as **MyNewChem for Test Run**, the first line of the text file might look like:

```
Desc & MyNewChem for Test Run & A hypothetical chemical used as an example
```

Note that each chemical has three very similar **ValueCode** entries: ***Desc***, ***Name***, and ***PSTNAM***. As discussed above, ***Desc*** must be a unique name. The descriptive name can include information that may identify it as being associated with a specific run or location. This approach is taken because you may sometimes have information about the chemical that is specific to your site or your group of simulations. For example, you may sometimes have a measured Kd value for the soil at a specific site. As another example, you may want to include specific distributions for some chemical parameters (Section 5.4) that are specific to your analysis.

The other two fields, ***Name*** and ***PSTNAM*** are much simpler. ***Name*** is intended to be the common name for the chemical. This is included solely for the convenience of the user and plays no other role in Gleams-Driver. ***PSTNAM*** is the name of the chemical that is entered into the GLEAMS pesticide input file. This name can be no more than 16 characters long. This is a limitation imposed by the GLEAMS program (not Gleams-Driver). ***Name*** and ***PSTNAM*** can be the same as long as the 16 character limit is not violated.

Complete example text files for importing chemicals are included in the **\Examples** subdirectory where Gleams-Driver is installed and a complete listing of all **ValueCode** entries that must be in text file are included in Appendix 2.

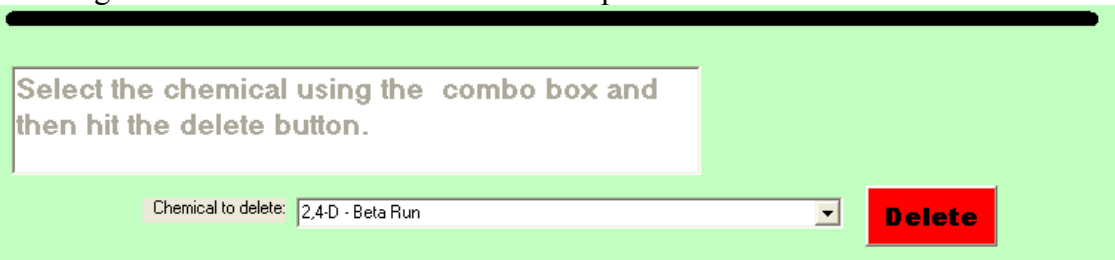
The middle section of the **Add or Delete Chemical** form gives a listing of the entry that you have selected. As illustrated below, the listing can be space filled so that ampersand symbols line up. This, however, is not necessary. All that is required is that the three fields (i.e., **ValueCode**, **Value**, and **Note**) are separated by ampersands.

```
H2OSOL    &   569              &   SERA TR 06-43-29-01c
HAFLIF    &   8.8              &   SERA TR 06-43-29-01c
KOC       &   61.7             &   SERA TR 06-43-29-01c
```

The **Note** field can contain as much text as you want but this field cannot contain any hard returns (line breaks). Line breaks can be use only to identify the start of a new set of values.

Once you have set the name of the text file and ensured that you want to import the new chemical, activate the Add button with the mouse cursor.

Deleting a chemical can be done at the bottom part of the **Add or Delete Chemical** form.

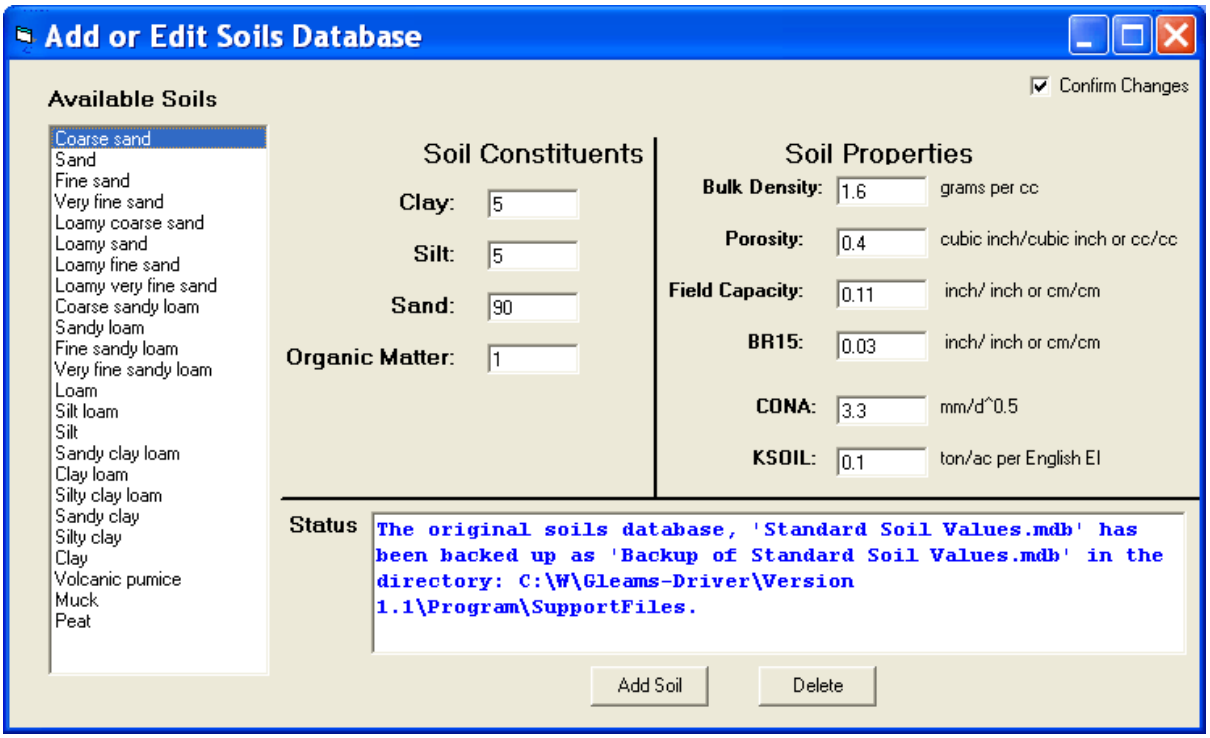


Simply use the combo box to select the chemical that you want to delete and then activate the Delete button.

6.4. Adding/Editing Soils

The information on soils used in a Quick Run is taken from **`Standard Soil Values.mdb`**, an Access database that is located in the **`\SupportFiles`** subdirectory where Gleams-Driver is installed. The **`Standard Soil Values.mdb`** database contains a table named **`SoilProps`** which contains basic information about a number of different soils.

A utility to add or edit the soils in the **`SoilProps`** data table can be accessed by activating the Utilities menu from the Gleams-Driver Main Screen and then selecting the Add/Edit soils option. This will activate the Add or Edit Soils Database form which is illustrated in Figure 19 and is reproduced below.



The Add or Edit Soils Database form has an **Available Soils** list box along the left hand side of the form, two data areas (Soil Constituents and Soil Properties), a status area, a Confirm Changes check box, and two command button: **Add Soil** and **Delete**. The **Available Soils** list box contains a list of all of the soils that are currently in your copy of the **SoilProps** data table of the **Standard Soil Values.mdb** database.

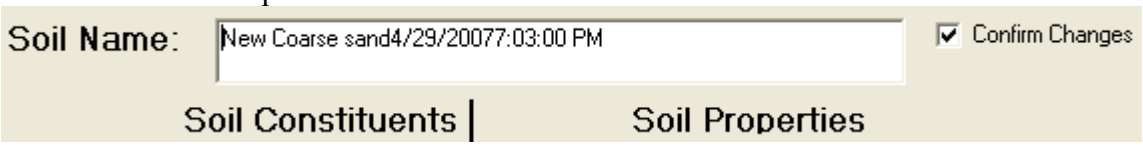
As soon as this form opens, the **Standard Soil Values.mdb** database is copied (before any changes are made) to a file called **Backup of Standard Soil Values.mdb**. If you make any unintended changes, you can simply exit this utility, erase the unwanted copy of **Standard Soil Values.mdb** database, and rename **Backup of Standard Soil Values.mdb** to **Standard Soil Values.mdb**. This last step is important because Gleams-Driver will not recognize the soil database unless it is named **Standard Soil Values.mdb**.

You can select a particular soil with either the mouse or the up and down arrow keys. As the selected soil changes, the values in the Soil Constituents and Soil Properties data areas will change to reflect the data in the **SoilProps** data table.

Each data area (Soil Constituents and Soil Properties) can then be edited directly. As soon as you make any change to any of the values, the command buttons at the bottom of the form with change as illustrated below:

The **Reset** button can be used to retrieve the original values from the **SoilProps** data table. The **Save** button will save the values to the **SoilProps** data table and the **Delete** button will remove the selected soil from the **SoilProps** data table. If the Confirm Change checkbox is checked (the default state), you will be prompted to accept or reject the changes that you have made.

Pressing the **Add Soil** button either before or after you make changes to the values will open the Soil Name field at the top of the form as illustrated below:



Note that a default name will be assigned to the new soil based on the soil that had been selected when you pressed the **Add Soil** button as well as the date and time. You will probably want to enter a different and more meaningful name and you will be prompted to do so by a beep and a message in the status area of the form.

The only limitation on the soil name is that the soil name cannot contain any single quote marks (**'**) or double quote marks (**"**). If you enter either of these marks in any way, the marks will be removed when you move to a different field and you will get a message indicating that the marks have been removed. Thus, if you enter **Georgia's "New Clay Soil"** as the soil name, you will get the error message and the name in the Soil Name box would be changed to **Georgias New Clay Soil**. This limitation is imposed by other uses of these symbols by the program. If you edit the **SoilProps** data table directly in Access, you will be able to enter either single quote marks or double quote marks but Gleams-Driver will generate an error and the program will terminate if you use any soil with these symbols in the name.

Once your have entered the new soil or made any changes to an existing soil, the new soil and the changes will be in effect the next time that you open the Quick Run window.

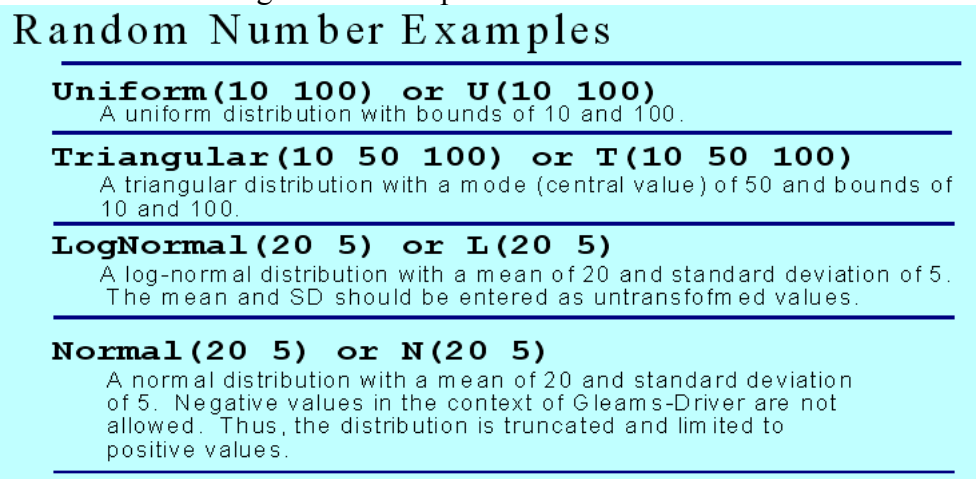
6.5. Testing Random Numbers

As noted in Section 5.4, the Gleams-Driver program allows for Monte-Carlo simulations of many of the variables that are used either in the pre-processor – i.e., to run GLEAMS – or the post-processor – i.e., to manipulate the GLEAMS output.

A utility for examining the generation of random numbers is available from the Utilities menu of the main program window (Figure 2). Select the Utilities menu item and then select the **Check Random Number Generator** submenu option. This selection will open the **Check Random Number Generator** form, illustrated in Figure 12.

As illustrated on this form, four common distributions are currently supported in Gleams-Driver: the uniform, triangular, normal, and log-normal distributions. The syntax for using these

distributions is illustrated in Figure 10 and repeated below.



The syntax used for entering random numbers in the Full Run data tables is identical to the syntax illustrated above and in Figure 12.

To test the random number generator, enter the initialization string (i.e., like the above examples) into the initialization string box. Then enter the number of random numbers that you want (a.k.a., the sample size) and the random number seed. The use of the random number seed is as discussed in Section 4.1.

Next, use the standard **Set** button to identify where you want the output file to be stored and the name that you want to use for the output file.

When this is done, simply activate the **Go** button. This will create an ASCII text file that will give the requested number or numbers from the specified distribution. Each number will be separated by a hard return. This text file format can be imported directly into any number of statistical packages for testing or fitting distributions.

In the development of Gleams-Driver, the standard Microsoft Visual Basic functions, **Randomize()** and **Random()**, are used along with commonly available algorithms for generating these very common distributions. These have been tested in Crystal Ball (Version 7) as well as StatGraphics (Version 5) and appear to work reasonably well. Testing a random number generator, however, can be done in many ways, some of which are very complex. The utility for generating random numbers to a text is added to Gleams-Driver to facilitate independent testing of the random number generators in Gleams-Driver.

6.6. About Window/System Information

The **About Window**, illustrated in Figure 13, can be opened from the main screen (Figure 2) by selecting the **About** menu item. The **About Window** itself is not a utility but it does specify the Version and Build number of Gleams-Driver. For example, Figure 13 identifies the Version as **1.8.180**, with **1** being the main version number, **8** being the subversion number, and **180** being the build number. [In programming jargon, a ***build*** occurs every time a program is compiled.]

It is anticipated that interim modifications (i.e., builds) may occur after the current release of Version 1.8. Thus, the build number that you see on your **About Screen** may be different from the one seen in Figure 13. The build number, which also appears on the Main Form, should be reported with any bug.

The **About Screen** also has a **System Information** button (labeled **System Info...** in Figure 13). By activating this button, the **System Information Window** will open. As illustrated in Figure 14, this window contains a great deal of information about your PC. This information (at least the information shown in Figure 14) may be useful in some cases to isolate and identify problems.

When reporting a bug, it could be helpful to send a screen shot of the System Information window, similar to that in Figure 14. None of the information on the **System Information** page that is illustrated in Figure 14 can be put to malicious use.

6.7. Technical Support and Problem Reporting

Other than this documentation, there is no formal mechanism for offering technical support. If you find problems that appear to involve programming errors or if you have request for program modifications or enhancements, please send an email to **mistretta@fs.fed.us** and/or **sera_inc@msn.com**. Attempts will be made to address programming errors in a timely manner.

In addition, it is likely that program modifications will be made as Gleams-Driver is applied in Forest Service risk assessments. For these reasons, you should check the SERA web site (**www.sera-inc.com**) for updates, additional documentation and other resources. At some point, these resources will probably be placed on a Forest Service web site. Links to these resources would probably be placed on the pesticides page maintained by USDA/FS/ Forest Health Protection (http://www.fs.fed.us/foresthealth/pesticide/).

7. POST-PROCESSING ALGORITHMS

As noted in Section 1, Gleams-Driver is both a pre-processor for GLEAMS (i.e., setting up input files) and a post-processor. This section describes the specific algorithms that are used in post-processing. For the most part, the algorithms used in Gleams-Driver are identical or very similar to the algorithms used in previous in-house SERA programs (SERA 2000, 2004). The only substantial change is in the algorithm used to estimate evaporation from a pond. This is detailed in Section 7.6 along with other algorithms used to consider water balance. Thus, parts of the following subsections are taken, with little or no modification, from SERA (2004).

The daily output file from GLEAMS can be found in the **`\Gleams Working Directory\Last Run`** (a subdirectory under the main Gleams-Driver directory) after Gleams-Driver is run and this file is always named **`OUTPUT.VAR`**. The **`Last Run`** subdirectory also contains all of the input and output files from the last GLEAMS run. If the user chooses to save all output files, the **`OUTPUT.VAR`** file is copied to **`\Gleams Output Files`**, a subdirectory that is created by Gleams-Driver in the directory specified by the user as the main driver file (Section 5). The file is renamed in a way to identify the simulation number – e.g., **`Daily VAR File Sim 0005 Site 01.txt`**. All of the post-processing of GLEAMS output done by Gleams-Driver is based on this file.

7.1. Concentrations in Soil

GLEAMS daily output files provide direct modeled estimates of the concentration of the pesticide in soil as output code **`18XXX`**, where **`XXX`** is a zero filled integer value for the chemical being modeled. This concentration is given in units of µg/g (equivalent to mg/kg or ppm). The concentrations, however, are given by computational soil layer.

Computational soil layers are developed internally by GLEAMS rather than being specified by the user. The number of computational soil layers is specified in GLEAMS output code 4001 The thickness of each computational soil layer (in inches) is output as GLEAMS code 4002 and the depth of each computational soil layer (also in inches) is output as GLEAMS code 4004. These codes all appear only once at the top of each GLEAMS daily output file.

For any soil depth requested by the user, Gleams-Driver calculates the average concentration in the soil layer using the depth weighted average of the soil concentrations reported by GLEAMS based on the concentrations in the computational soil layers (code **`18XXX`**) and the thickness of each soil layer (code 4002).

7.2. Maximum Penetration into Soil Column

Some individuals in the Forest Service have expressed an interest in knowing the maximum depth of soil penetration. GLEAMS does not report this other than providing non-zero concentrations of the chemical in soil layers. In making these estimates, GLEAMS assumes that when a chemical moves into a computational soil layer, the chemical is adsorbed onto the organic carbon and is uniformly mixed with the total soil mass in that layer. In reporting depth, Gleams-Driver simply uses the greatest depth of the computational soil layer that has any non-

zero value during the course of a simulation. This is only a crude measure of the maximum depth of penetration but it is the best that can be done with the GLEAMS output.

7.3. Nontarget Field

GLEAMS is an edge-of-field and bottom-of-root-zone model and does not provide information on contamination of an area adjacent to a treated field other than estimates of the amount of the pesticide lost in runoff water and sediment and percolate below the root zone. As discussed in Section 4.5, previous methods used in generic exposure assessments (SERA 2000, 2004) assumed that a field identical to the treated field is contaminated by runoff and sediment, both of which are output by GLEAMS. This amount was assumed to distribute evenly over the nontarget field. Assuming no degradation, the total loss from runoff and sediment was used to calculate a functional offsite application rate. This may seem like an overly conservative/ protective assumption that will grossly overestimate the exposure to the nontarget field. The zero degradation assumption, however, was employed in the absence of any better approach and in recognition of the possibility that runoff and sediment could concentrate in a much smaller nontarget area than the treated field. While the limitations of this approach were and remain apparent, no other alternative approach had been or has been suggested in the review of Forest Service risk assessments by Forest Service personnel, external reviewers, members of other governmental agencies, or members of the general public.

For a site-specific assessment using Gleams-Driver, the user is given the option of using no degradation, using the dissipation pattern from the treated field to model dissipation in the untreated field, or using a fixed field dissipation rate. The primary assumption in doing this is that the user can specify a reasonable and defensible area for the nontarget field based on site-specific information.

Using a fixed dissipation rate (i.e., k in units of $days^{-1}$), the amount at the site on a given day (Amt_x) is calculated as the amount from the previous day (Amt_{x-1}) plus the amount added by runoff and sediment loss (delta), and then, under the assumption of first-order dissipation, this total is multiplied by inverse of the natural log of the degradation rate:

$$Amt_x = (Amt_{x-1} + delta) \times e^{-k}$$

While a fixed field dissipation rate may be a modest improvement over the assumption of no dissipation, field dissipation rates taken from one study/location may not be applicable to the site that you are modeling. In addition, field dissipation is seldom a smooth first-order process over a prolonged period of time. Degradation will vary from day-to-day and season-to-season with differences in weather patterns. Specifically, the degradation rate is calculated in GLEAMS (by code designation) as a function of soil water content and soil temperature by computational layer. Degradation ceases when plant-available water content is at wilting point or soil temperature is at or below freezing.

This leads to the third option (which is the default in Gleams-Driver). Assuming that we have a nontarget field that is reasonably similar to the target field, the default option calculates a

functional dissipation for each day based on the decrease in the concentration of the pesticide in the total soil column at the target site. The calculation of concentration is described in Section 7.1. Under the assumption of first-order dissipation (at least during the single day), the functional k for a given day is calculated from the concentration on that day (C_t) and the concentration on the previous day (C_{t-1}) at the treated site:

$$C_t/C_{t-1} = 1-e^{-k}$$
$$e^{-k} = 1- C_t/C_{t-1}$$
$$k = -\ln(1- C_t/C_{t-1})$$

If more than one site contributes to contamination, the values for k are calculated for each site and are averaged. The value for k is then used as in the equation for a fixed dissipation rate under the assumption of first-order dissipation for the current day. The only exception involves a day on which an application is made. On such days, the soil concentration, C_t, will be greater than the concentration on the previous day, C_{t-1}, and the resulting value of k would be negative. Thus, on application days, no degradation is considered.

The functional offsite application rate is then reported (Section 8) as the maximum offsite application rate at any time during the simulation.

There are, of course, limitations and serious limitations with any of these approaches including the default approach. The utility and plausibility of the default approach will diminish as the differences between the nontarget field and the treated field increase. If the nontarget field is markedly different from the treated field or if the area of the nontarget field cannot be estimated well, the user should consider using the assumption of no degradation as a conservative/protective option.

What ever approach is selected, the rationale for selecting the approach should be clearly addressed in whatever analysis is being conducted.

7.4. Pesticide Concentrations in a Lake or Pond

7.4.1. Basic Algorithms

The algorithms for calculating concentrations in a lake or pond are similar to those used in previous generic exposure assessments (SERA 2000, 2004). The major difference is that the user is allowed to specify both a treated field area and total field area. The treated field area is used to calculate the amount of pesticide transported to the body of water. If water balance is considered (Section 7.6), the total field area rather than the treated field area is used to calculate the amount of water added to the pond or lake by runoff and/or percolation. If the total field area is greater than the treated field area, the modeled concentrations will be lower due to the increased amount of water added to the lake or pond. This same principal applies to a stream, creek, or river (Section 7.5).

The amount of chemical added on a given day in units of g/ha is read directly from GLEAMS output files (e.g., OUTPUT.VAR) and converted to units of grams in the program code:

```
TodaysAmnt = TodaysAmnt * FieldAreaMeters / 10000
```

The constant 10,000 converts field area in meters to field area in hectares. The total amount of the chemical in the lake on a given day is calculated as the amount at the end of the previous day (*Atot*) plus the amount added that day (delta):

```
Atot = Atot + delta
```

In considering the volume of water added to the pond by rainfall, runoff, and percolation, the water lost from the pond by evaporation is also considered.

The algorithm for considering evaporation from the pond or lake has been substantially modified from the previous programs (SERA 2000, 2004). In the previous generic exposure assessments, a relatively simple approximation of the daily evaporation rate recommended by Hamon (1961) and adapted by Haith and Shoemaker (1987) was used:

```
E(m) = 0.0021 L2 Psv ÷ (T+273.2) = 0.002167
```

where $E_{(m)}$ is evaporation in units of meters/day, L is the average number of daylight hours per day, T is the air temperature in °C, and P_{sv} is the saturated vapor pressure at temperature T. P_{sv} is calculated as:

```
Psv = 0.6108 exp(17.27 T) ÷ (273.2 + T).
```

This approach was taken in the absence of any detailed information on site-specific weather conditions. With the use of Cligen in Gleams-Driver, additional information is available and the method for estimating evaporation has been modified.

There are many algorithms for estimating evaporation, most of which are modifications to Penman's equation (Penman 1948). Initially, the recent publication by Terzi and Keskin (2005) was considered. On further examination, this approach was not used because it requires information on water temperature and air pressure as inputs (which are not directly available from Cligen). While methods might be developed for estimating these – e.g., convective heat transport to water as in Linacre (1992) – this was regarded as an unnecessary complexity. An additional disadvantage of the Terzi and Keskin (2005) method is that it is designed to model class A pan evaporation. Thus, a correction factor or algorithm would be required to translate pan evaporation to pond evaporation.

The relevant daily inputs that are available from Cligen include: precipitation, maximum temperature, minimum temperature, wind speed, solar radiation (Langleys/day), and dew point. Additional site specific parameters will include latitude, longitude, and elevation.

In a survey of the literature, a modification of the Penman equation proposed by Linacre (1993) was selected for use:

$$Eo = (0.015 + 0.00042\ T + 10^{-6}z)\ (0.8\ Rs - 40) + 2.5\ F\ u\ [T - Td]$$

where:

- Eo: evaporation from the pond in mm/day
- T: average of maximum and minimum daily temperature, °C ($[T_{max} + T_{min}]/2$)
- Td: dew point temperature, °C
- Rs: solar radiation to the pond surface (watts/ meter^2)
- z: elevation (meters)
- F: factor for change in air density with elevation: $1 - 8.7\times10^{-5}\ z$
- u: wind speed (meter/second)

In terms of using data from Cligen, the only non-trivial conversion is Langley/Day to watts/m^2:

$$\begin{aligned} \text{Langley/Day} &= 41.868\ \text{kJ/m}^2\ \text{Day} \\ &= 41{,}868\ \text{J/m}^2\ 86400\ \text{sec [86400 seconds per day]} \\ &= 0.4846\ \text{J/sec m}^2\ \text{[1 Watt = 1 Joule/sec]} \\ &= 0.4846\ \text{watts/m}^2 \end{aligned}$$

The volume of rainfall (*RainVol*) added to the pond in liters is calculated by converting the inches of rainfall to meters (0.0254 × inches = meters) and then multiplying the meters of rain by the number of square meters of surface area in the pond, yielding cubic meters of rain. This is converted to units of liters by multiplying by 1000 – i.e., 1 cubic meter is equal to 1000 L :

$$\text{RainVol (Liters)} = \text{Rain(inches)} \times 0.0254\ \text{(meters/inch)} \times \text{LakeArea (meters)} \times 1000\ \text{(liters/m}^3\text{)}$$

The volume of runoff (*RunoVol*) and percolation (*PercVol*) are calculated similarly except that the surface area of the field rather than the surface area of the pond is used. The field area used is the total field area – i.e., both the treated field as well as any untreated field specified by the users. The volume of water in the pond at the end of the day (V_w) is then calculated as:

$$V_w = \text{PreviousVol} + \text{RainVol} + \text{RunoVol} + \text{PercVol} - \text{Evap}$$

As discussed in Section 4, site-specific considerations may suggest that not all percolation volume should be added to the pond. The user is given the option of excluding all or part of the percolation volume. If percolation water is excluded or reduced, then the amount of pesticide in percolate is excluded or reduced by the same amount.

In some model runs involving very arid climates for very low initial water volumes in the pond, the volume of the pond can be substantially reduced by evaporative losses. If water balance is considered, it is assumed that the water volume will be maintained to some minimum volume specified by the user – i.e., underground streams. Thus, the total volume of the pond is not

allowed to go below this minimum (*MinVolume*). Currently, Gleams-Driver does not accommodate a dry pond and thus *MinVolume* must be greater than zero. A dry pond can be mimicked by setting *MinVolume* to a small positive value. In doing so, however, the user should consider the impact of differing degradation rates in dry soil versus water.

The next step in calculating the concentration of the pesticide in water involves calculating the concentrations in sediment. By definition:

$$Kd = Cs/Cw$$

where Cs and Cw are the concentrations in soil and water, respectively, and Kd is the partition coefficient. Using ***As*** and ***Aw*** for the amounts in soil and water and ***Vs*** and ***Vw*** for the volume of soil and water, this is equivalent to:

$$Kd = (As/Vs) \div (Aw/Vw) = Cs/Cw.$$

The total amount, *Atot*, will be equal to *As* + *Aw* and thus,

$$Aw = Atot-As.$$

Substituting this into the equation for *Kd*,

$$Kd = (As/Vs) \div ((Atot-As)/Vw)$$

and solving for *As*,

$$As = (Atot \times Kd \times Vs)/((Kd \times Vs) + Vw))$$

Aw can then be calculated as above (*Atot-As*) and the concentration in both water and sediment can be calculated.

Degradation in water and sediment is assumed to follow first order kinetics. Typically, this is characterized as halftimes and the degradation rate constants, k_{Wat} and k_{Sed} are calculated from the relationship, $k= \ln(2)/t_{1/2}$. Thus, the mass of the chemical in sediment and water at the end of each day is calculated as:

$$As = As \times \exp(-k_{Sed} \times 1 \text{ day})$$

$$Aw = Aw \times \exp(-k_{Wat} \times 1 \text{ day})$$

The concentration in the water (*Cw*) at the end of the day is then calculated as the amount of the compound in the water (A_w as defined above) divided by the volume of water at the end of the day (V_w) as defined above. The concentration in sediment can be calculated from the definition of Kd:

$$Kd = Cs/Cw$$

$$Cs = Kd \times Cw$$

7.4.2. Options for Water Balance

7.4.2.1. Reservoirs

As discussed in Section 4.6.4 (Quick Run – Water Body Options), Gleams-Driver allows you to define three virtual reservoirs:

Perc: designating the percolate loss (water and chemical) from the field

Runo: designating the runoff (water and chemical) loss from the field

Sedi: designating the sediment (mass of sediment and chemical) loss from the field.

For each of these reservoirs, you can specify four parameters:

MediaLossRate: the first-order rate constant for loss of the water or sediment from the reservoir to the water body in units of day^{-1}

ChemLossRate: the first-order rate constant for loss of the chemical from the reservoir to the water body in units of day^{-1}

ChemDegRate: the first-order rate constant for degradation of the chemical in the reservoir in units of day^{-1}

PropLost: the proportion of loss from the field to the reservoir

In a Quick Run, these are entered in the Options Box in the Water Body section of the Quick Run screen as:

PercMediaLossRate = 0.05, PercPropLost = 0.9.

In a Quick Run, these are always assigned to a single site/treated field that is designated as **Site01**.

In the Full Run facility, these options must be entered in the **Waterbodies** data table of the Access input database and they must be associated with a site – i.e., the field that generates the percolate, runoff, and/or sediment. This association is made by specifying the name of the site followed by the reservoir parameters and values. Thus, for a site designated as **Site01**, the above options for the percolation loss rate and proportion of percolation would be entered as:

Site01[PercMediaLossRate = 0.05, PercPropLost = 0.9].

As described in Section 4.6.4, these options alter the way that water, sediment, and the chemical are moved from percolation, runoff, and sediment output from GLEAMS

7.4.2.2. Evaporation

Fore each site/treated field in the **SITES** table of the Access input database, a **FLGPEN** option may be specified to designate the algorithm that is used to calculate evapotranspiration. This can only be set using the Full Run facility. Allowable values are:

0 - the Priestly-Taylor algorithm for ET
1 - the Penman-Monteith algorithm for ET

If no value is specified, the Penman-Monteith algorithm is used. See the GLEAMS 2000 documentation (Knisel and Davis 2000, p. 22) for a fuller discussion.

The evapotranspiration output from GLEAMS can be used as an alternative to the Linacre algorithm detailed in Section 7.4.1 for estimating evaporation from the pond. The evaporation algorithm can be adjusted with the **EvapOpt**, Evaporation Option, value code in the **Waterbodies** Access input data table. The options are:

Linacre(x.xx)
or
GLEAMS(x.xx)

The argument, x.xx, can be a number greater than or equal to zero. The argument is used a multiplier to adjust the evaporation. If no argument is specified – i.e., the parentheses are omitted or are given as () – a default value of 1 is used.

If **GLEAMS(x.xx)** is specified, evaporation will be calculated based on potential evapotranspiration. As discussed above, evapotranspiration will be calculated using either the Priestly-Taylor algorithm or the Penman-Monteith algorithm depending on the setting of the **FLGPEN** site option. In either case, the value of **x.xx** should be used and should be set to a value of greater than 1.0 because potential evapotranspiration from soil and vegetation will generally be less than evaporation from a standing body of water. Further generalizations, however, cannot be offered and it is the responsibility of the user to select and justify the value for **x.xx**.

If you select **Linacre(x.xx)** as the evaporation option, arguments of less than one might be judgmentally applied to bodies of standing water that are heavily shaded or otherwise located in areas that might reduce evaporation (e.g., protected from wind). Otherwise, adjustments to evaporation should not be applied unless you have some explicit justification – e.g., you are calibrating the model to a specific site where you have data on water volumes that justify a value other than one (1.0).

7.5. Pesticide Concentrations in a Stream

This part of the Gleams-Driver program implements a general point source dilution model for stream flow:

$$\text{Conc (amount/L)} = \text{delta (amount/day)} \div \text{Flow(L/day)}$$

or

$$C_S = \boldsymbol{\delta} \div F$$

where **δ** (delta) is the daily load to the stream and C_S is the concentration in the stream. This is a point source model. In the context of the a rights-of-way or treated field, this approach essentially assumes that all of the loss from the treated field is channeled so that it enters the stream at a single point. The length downstream that is contaminated is simply the daily flow rate of the stream. This length of stream is modeled to have the concentration, C_s, calculated above.

For each day, the load to the stream is in units of g/ha and converted to g/day by:

$$\boldsymbol{\delta}_{(g/day)} = \mathbf{Loss}_{(g/ha/day)} \times A_{(ha)}$$

where $A_{(ha)}$ is the area of the treated field in hectares.

The value of **δ** ÷ F is the concentration at the point source and the concentration that would remain in the water if no degradation were to occur. Using a first order degradation rate coefficient of k ($days^{-1}$), the concentration at a distance, *d*, downstream may be calculated as:

$$C_S = (\boldsymbol{\delta} \div F)e^{-k\,d/v}$$

where d is the distance in meters and v is the velocity of flow in meters/day. *Cs* is the concentration at the specified distance, d, downstream. Note that d/v is simply the time it takes to travel distance d and thus the expression k d/v is unitless: ($hr^{-1} \times (m \div (m/hr))) = hr^{-1} \times hr =$ unity.

The average concentration in the stream from the input point source to a point ***d*** meters downstream may be calculated as the integral of C_S between zero and d divided by the distance, d:

$$C_{Ave} = [(\boldsymbol{\delta}\, v)/(k\, F) - (\, \boldsymbol{\delta}\, v\, e^{-k\, x/v} / (k\, F)\,)] \div d$$

For a typical scenario, the distance, d, is set to the length of the stream that will be contaminated in a single day - i.e., equivalent to the flow velocity in meters/day. The longer the distance, the lower the average concentration over the length, ***d***, because of the increased time and hence increased degradation.

As with the lake scenario described in the previous section, the amount of water entering the stream through rainfall, percolation, or runoff may considered. The algorithms are essentially identical to those used for the pond scenario except that evaporation is not considered - i.e., the source water and thus the flow rate for the stream is presumed to be constant except on days in which rain occurs.

Structurally, pesticide binding to sediment is built into the Gleams-Driver algorithms and the input files for a stream. Soil binding, however, has not yet been implemented in the algorithms for the stream. Thus, as with previous methods, binding to sediment is not used to estimate concentrations in stream water – i.e., the stream bed is assumed to consist primarily of rock. This is a conservative assumption in that it leads to somewhat higher estimates of concentrations of the pesticide in water.

In terms of estimating rainfall – as well as scenarios that involve contamination from drift – the width of the stream is used to estimate the amount of water added by rainfall or drift.

The reservoir options can be used with the stream in that same way that they can be applied to ponds. See Section 4.6.4 or Section 7.4.2.1 for additional details. Evaporation is not currently considered in stream modeling because reliable methods for estimating evaporation from a moving body of water have not been encountered. The testing of Gleams-Driver that has been conducted to date suggests that the reservoir options are sufficient for calibrating the stream component in Gleams-Driver.

7.6. Consideration of Water Balance

As noted in Section 1, the use of GLEAMS modeling in older risk assessments did not consider water balance (SERA 2000). In response to peer review comments, the consideration of water balance was subsequently added (SERA 2004).

The consideration of water added to the stream as well as the pond can have a substantial impact on the modeled concentrations, which will be lower if the added water is considered compared to concentration in which the contribution of rainfall, runoff, and percolation is ignored. Because of the lower estimates of concentrations of pesticides in water that result from the consideration of water balance, this consideration may be viewed as anti-conservative or non-protective. To address this in generic exposure assessments, the consideration of water balance is accompanied by very conservative assumptions such as only considering water inputs from the treated field (SERA 2004).

With the release of Gleams-Driver, the user has the opportunity to consider both the treated and untreated field area. As the area of the untreated field increases with respect to the area of the treated field, the estimated concentrations in a pond or stream will decrease. To the extent that the consideration of the untreated field area is well-documented and supported by site-specific conditions, the resulting estimates should better reflect concentrations that are plausible.

Nonetheless, the user is given the option to ignore water balance, and this will result in higher modeled concentrations. The decision to consider or not consider water balance for either a pond or stream should be based on site-specific considerations and some level of common sense. If you are treating a substantial portion of the watershed of a relatively small body of water, then considering water balance is clearly sensible. As the size of the watershed and the complexity and size of the water bodies increase, the relatively crude approximations used in Gleams-Driver may be less defensible and you may want to at least look at two analyses, one considering water balance and the other not considering water balance.

As with any other aspect of exposure assessments, the rationale for electing to either consider or not consider water balance and the consequences of this decision should be articulated clearly in documentation for a specific analysis.

8. REPORTS AND DATABASES

Running Gleams-Driver will generate two ASCII text files: an error file (Section 8.1) and a summary of the results (Section 8.2). Gleams-Driver will also create one Access database (Section 8.3) and may create a large number of other files (Section 8.4).

8.1 Error Files

With Gleams-Driver Version 1.8, the structure of the error reporting has been changed to accommodate the ability of Gleams-Driver to do a series of runs in a single session, as detailed in Section 3.2. As in previous versions, Gleams-Driver will create a general error file that is always named **`Errors in GLEAMS Driver Run.txt`** and this file is placed in the directory where Gleams-Driver is installed. Unlike previous version, however, this file will contain only general errors that are associated with the installation of Gleams-Driver or user interactions with the various forms/screens that Gleams-Driver can display.

Each time that a simulation is started, however, errors are redirected to a run-specific error file. This file will be named **`Errors File for XXXXXX.txt`**, where **`XXXXXX`** is the name of the driver file used to initiate the run and this run-specific error file will be located in the same directory as the driver file.

If any internal errors or warning messages are generated during a single Quick Run or Full Run, a Run Error Report form will be displayed indicating that an error has occurred. If you are doing a Series Run, the display of run-specific error files is suppressed. This error suppression is necessary in order to allow other runs to proceed – i.e., if you a doing 10 runs overnight, you would not want an error or warning in the second run to stop all of the other runs from proceeding. **Thus, before using any results, you should check each run-specific error file after a Series Run is completed.**

As illustrated in Figure 15, the Run Error Report form contains a brief message indicating that error and/or warning messages were generated. This form will also specify the name and path of the run-specific error file. In addition, this form will contain a full text copy of the run-specific error file.

If there are no errors or warnings, the Run Error Report form will not be displayed. Instead, a standard message window (illustrated to the right) will display indicating that no errors or warnings occurred.

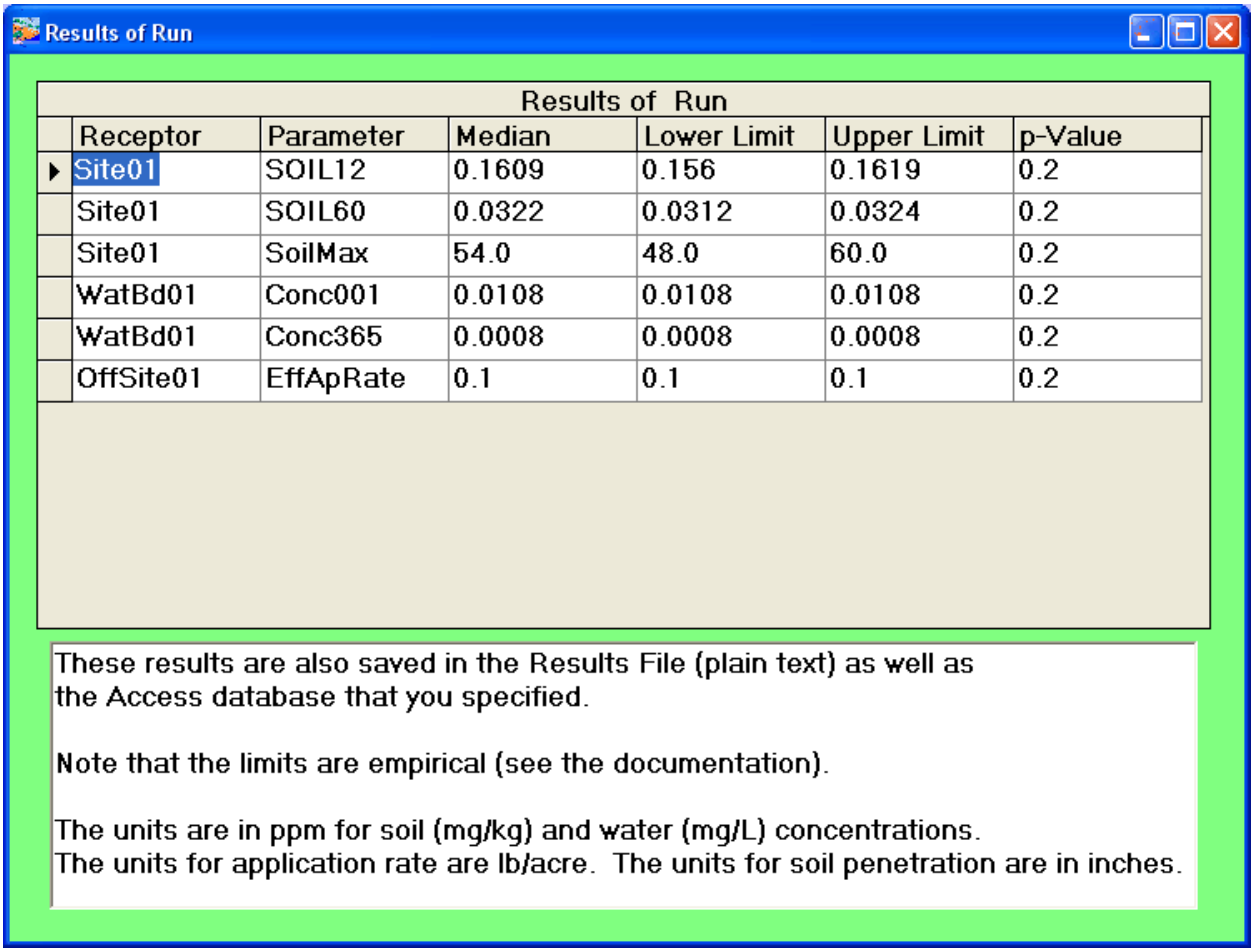
If a Run Error Report form is displayed, you should read the error and warning messages and attempt to correct the problem. If the error messages indicate that a programming error has been detected, please report this error (Section 6.7). If you elect to report programming errors (Section 6.6), please include the general error file (**`Errors in GLEAMS Driver Run.txt`**), the run-specific error file and the Access input database. This

may help to identify and correct the error(s).

Even if no errors occur (the run-specific error file is not displayed), you may want to review the run-specific error file. The top of the error file will give the Gleams-Driver version number, the name of the driver file, and the date and time that the Gleams-Driver program was started. The run-specific error file will also show the number of runs that were done and the start and end times for the simulations. This is followed by the number of simulations that were done, the number of GLEAMS runs that were done, the number of error messages and warnings. The last section of the error file, gives the total run time and the average number of seconds that each run took.

8.2. Summary Table

When the simulation is completed, Gleams-Driver will display a form that summarizes the results of the simulations. This form is illustrated in Figure 16 (and in also embedded below). The same information is also written to a plain text output file. This output file is included in the same directory where the Access driver database is located. The file will be named **`Results - XXXXXXX.txt`**, where **`XXXXXXX`** is the name that you used to identify the simulation.



Each summary table and summary text file has six columns. The first column identifies the receptor, the item to which the results apply. In a Quick Run, the receptors are given consistent names: **Site01** for the treated site, **OffSite01** for the nontarget field, and **WatBod01** for the water body that was modeled. In a Full Run, the names that appear in the first column will be the receptor codes that you defined in the data table (Section 5).

The second column gives the parameter for which statistics are reported. In a Quick Run, the second column will always include the concentrations in the top 1 foot and 5 feet of soil at the treated site, the maximum depth of modeled penetration into the soil column, the peak and yearly concentrations of the pesticide in the water body modeled, and the effective offsite application rate for the nontarget field. The algorithms used to calculated these output parameters are given in Section 7.

The third, forth, and fifth columns give the median value, the lower empirical limit and the upper empirical limit for the value. Note that the median and not the average value is reported. The median is simply the middle value. For example, in a ordered set of 21 numbers, the median value is the 11th number in the series. If an even number of runs are done, the median is reported as the next higher value. Thus, if 20 runs are done, the median value is also reported as the 11th number in the series. As indicated in Figure 16, all results are given in units of mg/L for concentrations in water, mg/kg for concentrations in soil, inches for penetration into soil, and lb/acre for functional offsite application rates.

The p-value for the limits is given in the sixth column. Note that the p-value is two-tailed. Thus, a p-value of 0.05 as in Figure 16 indicates that the lower limit is the 5th percent value and the upper limit is the 95th percent value. This range corresponds to a 90% empirical confidence interval rather than the standard 95% interval.

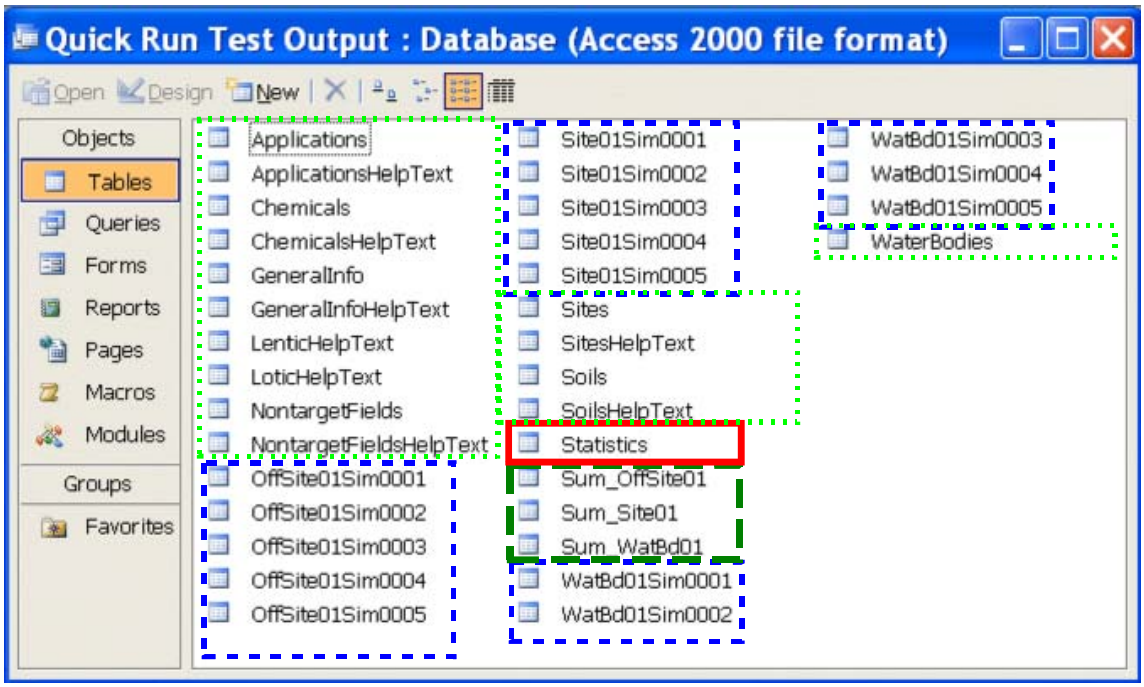
Note also that the limits are empirical rather than statistical. In other words, no assumption is made about the underlying distribution of the values. The 5th percent value is simply the record that corresponds to the number of records multiplied by 0.05 when the records are sorted by the value that is reported. Any fractional value is rounded up. Thus, if there were 41 simulations, the 0.05 limit would be calculated as record number 2.05 [41 × 0.05] which would be rounded up to 3 and the third record in the sorted set would be given as the lower empirical limit.

Internally, Gleams-Driver will try to calculate the limits based on a two-tailed p-value of 0.025, corresponding to an empirical 95% confidence interval. The p-value that is reported, however, may be limited by the number of simulations. To get a p-value of 0.025, at least 40 simulations must be conducted. If only 5 simulations are conducted, the p-value would be 0.2 and the limits would cover the middle 60% – i.e., 1 - (0.2 × 2) for a two-tailed limit.

The information in the above output report form is copy of the Statistics data table in the Access Output Database. A copy of this information also included in an ASCII text file in the same directory where the Access Input file is located. The ASCII text file will be named **Results - XXXXX.txt** where **XXXXX** is the name of the name of the run.

8.3. Access Database

With each set of simulations, Gleams-Driver creates a single Access output database. The name of this database is given by the user on the Quick Run form (Section 4.1) or specified by the user in the General Information data table (Section 5). For those not familiar with MS Access or other relational databases, note that a database is defined as a set of one or more data tables. Each data table consists of records (i.e., rows) and fields (i.e., columns). The number of tables and the names of most of the tables in the database will vary depending on user input. An overview of a typical database from a Quick Run is given in Figure 17 and is illustrated below.



Every database will have one table named **Statistics**. This table is outlined by **a red solid line box** in Figure 17. The information in this table is identical to the information in the output form and output text file described in Section 8.2.

Each receptor included in the run – i.e., each treated field, nontarget field, and body of water – has its own summary data table. The name of the data table starts with **SUM_** followed by the receptor code given by the user (or assigned by the Quick Run) to identify the receptor. The three summary tables illustrated in Figure 17 and outlined in a **green dashed line box** are **SUM_Offsite01** (for the nontarget field), **SUM_Site01** (for the treated field), and **SUM_WatBod01** (for the nontarget body of water). These summary tables will contain the results of each run. Thus, if you do 100 simulations, each of these tables will have 100 records.

The first field in each of the summary tables will be **SimNo**, an integer that identifies the

simulation number. Other fields in the summary table will be identical in name to the parameter requested by the user. For example, the other fields in the **SUM_Site01** table are **SOIL12** (the concentration of the pesticide in the top 12 inches of soil in ppm), **SOIL60** (the concentration of the pesticide in the top 60 inches of soil in ppm), and **SoilMax** (the maximum penetration of the pesticide into the soil column in inches).

Similarly, **SUM_WatBod01** has the **SimNo** field and two additional fields, **Conc001** and **Conc365**. **Conc001** is the peak concentration in mg/L (equivalent to the highest 1-day time-weighted average). **Conc365** is the highest 365-day time-weighted average. Similarly named fields will be present if the user requested time-weighted averages for other durations.

Keep in mind that all time-weighted average concentrations are maximums. For any given period of time, it make no sense to speak of average TWA concentrations over longer periods because they will always equal the average concentration of the longer period of the simulation (at least approximately so) – i.e., the average 4-day TWA concentration over the course of a year will be the average annual concentration.

The summary table for the nontarget site, **SUM_Offsite01**, will have the **SimNo** field and one and only one additional field, **EffApRate**, the effective offsite application rate in lbs/acre. No other summary statistics are supported for the nontarget field.

If you elected to Save Intermediate Data on the Quick Run Screen or if you set SaveDaily to Yes in the GeneralInfo table for a Full Run, each output Access database will have at least one daily table for each receptor. In the example given in Figure 17, these tables are identified in blue dotted lines and are named with the code for the receptor: **OffSite01** (for the nontarget field), **Site01** (for the treated field), and **WatBod01** (for the nontarget body of water). For example, **WatBod01Sim005** contains all of the daily records for the 5th simulation (**Sim005**) for the nontarget body of water.

Each of these tables will have the daily records for the last simulation that was run. For the most part, the names of the fields in these daily tables are descriptive and correspond to the field names in the summary tables, discussed above. Raw data fields in the data table for the treated site – i.e., **Site01** in the example illustrated in Figure 18 – are exceptions.

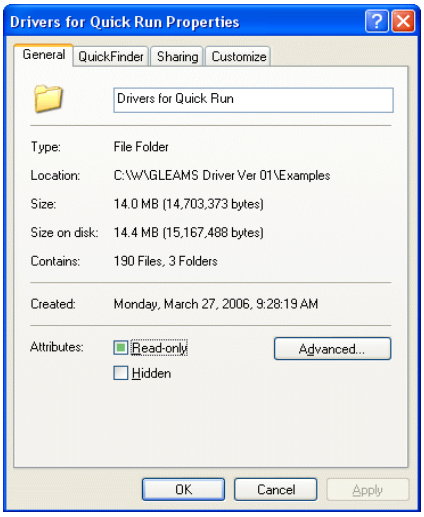
As illustrated in Figure 18, the daily data tables for the treated sites contain the fields for the date (**ThisDate**), the Julian Day (**JDAY**) and other raw daily output values from GLEAMS as read from the **OUTPUR.VAR** file.

To facilitate quality control, the names of the raw data fields are based on corresponding GLEAMS codes. Thus, **Cd00001** is GLEAMS code 1, **Cd00002** is GLEAMS code 2, and so on. If you are not familiar with GLEAMS, these codes will have no meaning and you should not be concerned with them. If you are familiar with GLEAMS and want to ensure that the information is being correctly read by the Gleams-Driver program, you can compare the appropriate

OUTPUR.VAR file to the values in the data table for a treated site using the Julian Day as the common reference point.

Lastly, each output Access database will contain copies of all of the tables from the Access input database. In Figure 17 and in the copy of this figure on the previous page, these input tables (outlined in light green dots) include Applications, Chemicals, GeneralInfo, NontargetFields, Sites, Soils, and Waterbodies as well as the help tables for each of the input data tables – e.g., ApplicationsHelpText. The structure of these input tables is discussed further in Section 5.1 and is illustrated in Figure 6. These input tables are included in the output database to ensure that the results of the simulation are clearly and transparently linked to the input parameters used to generate the simulation. The only input table that is modified is GeneralInfo. In the output database, this table contains the version number that was used in the simulation as well as the start and end dates and times for the simulation.

8.4 Other Files



Gleams-Driver may create a large number of files. While some files that Gleams-Driver creates may be reused, Gleams-Driver is programmed not to delete files that it creates.

If you indicate that all raw data and intermediate files should be saved, Gleams-Driver can create a large number of files. For example, take a very simple Quick Run based on only 20 simulations (a much smaller number than would be used in any serious analysis). For this example, Gleams-Driver created three subdirectories with 190 files that occupied 14.4 megabytes of disk space.

As noted in Section 4.7, you should be very aware of this feature if you do a large number of simulations and request that all input, output, and intermediate files are to be saved. This may be worth doing in the interest of transparency. However, if the random number seed is fixed (Section 4.1), your analysis will be reproducible by anyone. From a practical point of view, the option to save all files is intended as a quality control tool and will typically be applied to relatively small numbers of simulations.

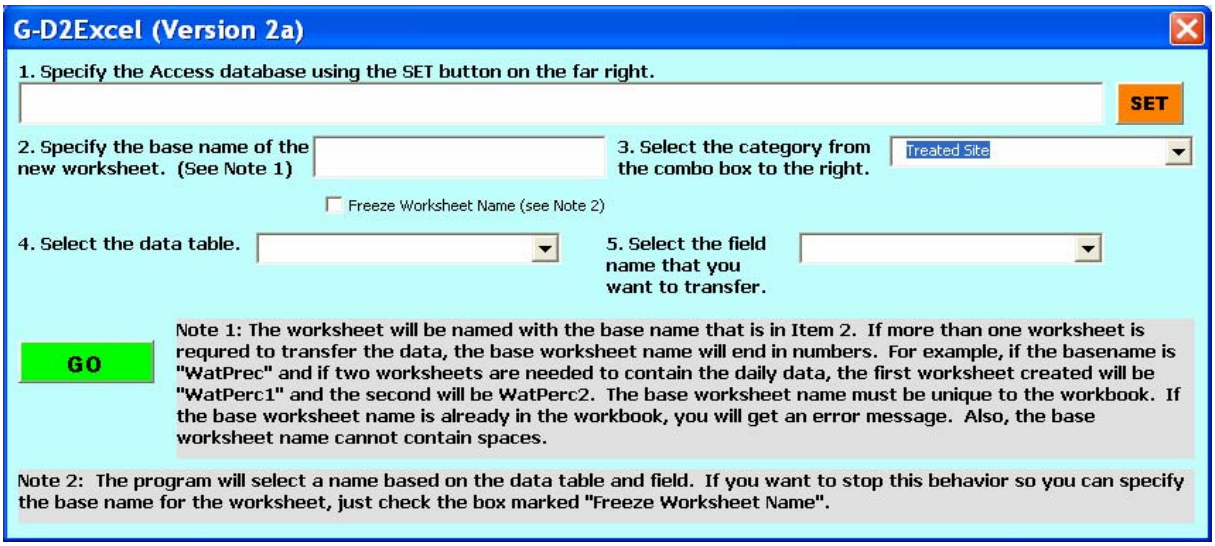
8.5. M.S. Office Utilities for Using and Documenting Gleams-Driver Results

The USDA Forest Service uses Microsoft Office and most individual in the Forest Service are fluent in both MS Word and MS EXCEL. To facilitate the use of Gleams-Driver, various MS Office utilities have been developed and are available in a zip file (**G-D Utilities.zip**) at the SERA web site: www.sera-inc.com. If you need information on a Gleams-Driver run beyond the summary statistics provided in the standard output file (Section 8.2), it may be worth your time to become familiar with at least some of these utilities.

Each utility is relatively simple and instructions are provided in each utility. A brief annotated list of the utilities is given below.

8.5.1. G-D2Excel Version 02b.xls

This is by far the most useful utility for examining the results of a Gleams-Driver in detail. This utility allows you to transfer daily time series data from an M.S. Access output database generated by Gleams-Driver to an EXCEL workbook. Depending on the number of simulations, the data may be placed in more than one worksheet. After activating the START button in the



EXCEL file, a window/form like the one illustrated below will open.

Use the SET button on this form to select the Access output file from Gleams-Driver. Use the combo boxes to select the category (treated site, untreated site, or body of water) as well as the Access Table and the Field in the table that you want to transfer

Once you have set the necessary values, press the GO button on the form and the data will be transferred and plotted. The data are output for the variable that you select and the data are summarized by central estimates as well as upper and lower bounds. The first worksheet with the transferred data will have a plot of the data and will offer various options for plotting the data. The plot may be rather crude and require some manual editing but it's a start.

8.5.2. USGS Pond Reader Version 1.0.xls

This utility allows you to transfer daily time series data on pond/lake volume from a USGS text file to an EXCEL spreadsheet. As discussed in Section 5.6, the text files can be obtained from the USGS National Water Information System (http://waterdata.usgs.gov/nwis).

You may want to edit the text file so that only full years are included but this is not necessary. You can have up to 244 years. It is not likely that you will have more years of historical data. Each year is put into a column. The column label has the year for the flow rates. Each year is treated as if it were a leap year. For convenience, the year 2000 is used.

As the data are added, the USGS units (acre feet or Mgal) are converted to Liters, the unit used

in stream flow output by Gleams-Driver. The conversion is based on:

1 Mgal = 1 million gallons = 3.07 acre feet
1 acre foot = 0.326 Mgal = 326,000 gallons
1 gallon = 3.785 liters

You must specify the units that the data are in. When all of the data are transferred, formulae are put in the spreadsheet that will give you the median, 5th percentile, and 95th percentile for each day of the year. You can change the limits of the percentiles if you want. This utility can be used to calibrate Gleams-Driver to a specific pond/lake or to assess the ability of Gleams-Driver to model pond or lake volumes.

8.5.3. USGS Stream Reader Version 1.0.xls

As the name implies, this utility is similar to the above utility on ponds. Except for the conversions, the operation of this utility is identical to that of the pond utility. For the stream utility, the USGS data on stream flow are given in cubic feet per second and these data are converted to Liters/day, the unit used in stream flow output by Gleams-Driver.

8.5.4. Gleams-Driver Run Inputs Ver 01b.Doc

This is an MS Word utility for transferring information on the input parameters used in a Gleams-Driver run from a Gleams-Driver output Access file to Microsoft Word file. [Note: Since Gleams-Driver Version 1.4, all of the information from the Access input database is copied to the Access output database created by Gleams-Driver. This approach is taken as a quality control measure and to ensure the documentation of each run.] This utility is very simple. You just select the Gleams-Driver Access output database and all of the inputs are transferred to a new MS Word document. Five tables will be created in the new docuement:

General Run Information
Chemical Information
Site Information
Information on Water Body/Bodies
Information on Adjacent Field

You will need to save the newly created document with a name and in a place of your choosing.

8.5.5. SERA File Lister.doc

This utility has nothing to do directly with Gleams-Driver. It is an internal SERA tool that simply lists all of the files in a user-specified directory and any subdirectories. This tool is provided to user's of Gleams-Driver because, as noted in Section 8.4, Gleams-Driver can generate a large number of files. You can use SERA File Lister.doc to create a table or tables to document all of the input and output files associated with a Gleams-Driver run.

9. REFERENCES

Anderson MP; Woessner WW. 2002. Applied Groundwater Modeling: Simulation of Flow and Advective Transport. Academic Press, New York, NY. 381 pp.

Boulding JR. 1995. Practical Handbook of Soil, Vadose Zone, and Ground-Water Contamination. Lewis Publishers, Boca Raton, Florida, 948 pp.

Cohen SZ. 1996. J Environ Sci Health B. Pesticides in ground water in the United States: monitoring, modeling, and risks from the U.S. perspective. 31(3): 345-52.

Connolly RD; Kennedy IR; Silburn DM; Simpson BW; Freebairn DM. 2001. Simulating endosulfan transport in runoff from cotton fields in Australia with the GLEAMS model. J Environ Qual. 30(3): 702-13.

de Paz; Ramos C. 2002. Linkage of a geographical information system with the gleams model to assess nitrate leaching in agricultural areas Environ Pollut. 118(2) :249-58.

Djodjic F; Montas H; Shirmohammadi A; Bergstrom L; Ulen B. 2002. A decision support system for phosphorus management at a watershed scale. J Environ Qual. 31(3): 937-45.

Effland, W., N. Thurman, I. Kennedy, R.D. Jones, J. Breithaupt, J. Lin, J. Carleton, L. Libel. R. Parker, and R. Matzner. 2000. Guidance for use of the index Reservoir and Percent Crop Area Factor in drinking water exposure assessments. Office of Pesticide Programs.

Fetter CW. 2001. Applied Hydrology. 4th Edition. Prentice Hall, Upper Saddle River, NY. 598 pp.

Flanagan DC; Nearing MA. 1995. USDA Water Erosion Prediction Project: Hillslope Profile and Watershed Model Documentation. NSERL Report No. 10. USDA-ARS National Soil Erosion Research Laboratory, West Lafayette, Indiana. Report available at: http://topsoil.nserl.purdue.edu/nserlweb/weppmain/docs/readme.htm. Program available at: http://topsoil.nserl.purdue.edu/nserlweb/weppmain/data/downloads.htm

Garnier M; Lo Porto A; Marini R; Leone A. 1998. Integrated Use of GLEAMS and GIS to Prevent Groundwater Pollution Caused by Agricultural Disposal of Animal Waste Environ Manage. 22(5): 747-56.

Gustafson JB; Tell JG; Orem D. 1997. Total Petroleum Hydrocarbon Criteria Working Group Series. Volume 3: Selection of Representative TPH Fractions Based on Fate and Transport Considerations. Amherst Scientific Publishers, Amherst, Massachusetts. Available at: http://www.aehs.com/publications/catalog/contents/Volume5.pdf.

Haith DA; Shoemaker LL. 1987. Generalized watershed loading functions for stream flow nutrients. Water Resources Bulletin. 23: 471-478.
Hamon WR. 1961. Estimating potential evapotranspiration. J. Hydraulics Division, ASCE. 87(HY3): 107-120.

Hampshire Research Institute, Inc. 1995. Stream Model Scientific Guide, In: Documentation for Version 1.1, Risk* for Windows, pp. 255 to 271. Thistle Publishing, Inc., Alexandria, VA.

Jones RL; Mangels G. 2002. Review of the validation of models used in Federal Insecticide, Fungicide, and Rodenticide Act environmental exposure assessments. Environ Toxicol Chem. 21(8): 1535-44.

Knisel WG; Davis FM. 2000. GLEAMS (Groundwater Loading Effects of Agricultural Management Systems), Version 3.0, User Manual. U.S. Department of Agriculture, Agricultural Research Service, Southeast Watershed Research Laboratory, Tifton, GA. Pub. No.: SEWRL-WGK/FMD-050199. Report Dated May 1, 1999 and revised August 15, 2000. 194pp.

Knisel WG; Leonard RA; Davis FM; Sheridan JM. 1991. Water Balance Components in the Georgia Coastal Plain: A GLEAMS Model Validation and Simulation. J Soil Water Conservation. 46(6): 450-456.

Knisel WG; Davis FM; Leonard RA. 1992. GLEAMS, Version 2.0, Part III. User Manual. U.S. Department of Agriculture, Agricultural Research Service, Southeast Watershed Research Laboratory, Tifton, GA. 202 pp.

Leng ML; Leovey EMK; Zubkoff PL. 1995. Agrochemical Environmental Fate: State of the Art. Lewis Publishers, Boca Raton, Florida, 410 pp.

Leonard RA; Knisel WG; Still DA. 1987. GLEAMS: Groundwater Loading Effects of Agricultural Management Systems. Trans Amer Soc Agr Engineers 30(5): 1403-1418.

Leonard RA; Knisel WG; Asce M; Davis FM; Johnson AW. 1988. Modeling pesticide metabolite transport with GLEAMS. In: Proc on Irrigation and Drainage Planning. pp. 255-266.

Linacre ET. 1992. Climate Data and Resources. Published by Routledge, Chapman and Hall, Inc. NY, NY. 366 pp.

Linacre ET. 1993. Data-sparse estimation of lake evaporation, using a simplified Penman equation. Agricultural and Forest Meteorology. 64: 237-256.

Linacre ET. 1994. Estimating U.S. Class-A pan evaporation from few climate data. Water International. 19: 5 - 14.

LOICZ (Land-Ocean Interactions in the Coastal Zone). 2000. LOICZ - Biogeochemical Modeling Node. International Geosphere-Biosphere Programme (IGBP) of the International Council of Scientific Unions. Http://data.ecology.su.se/mnode/Methods/PRECEVAP.HTM. Page updated July 31,2000.

Lorber MN; Mulkey LA. 1982. An evaluation of three pesticide runoff loading models. J Environ Qual. 11(3):519-529.

Ma QL; Smith AE; Hook JE; Bridges DC. 1999. Surface transport of 2,4-D from small turf plots: observations compared with GLEAMS and PRZM-2 model simulations. Pesticide Science. 55: 423-433.

Mueller TC; Jones RE; Bush PB; Banks PA. 1992. Comparison of PRZM and GLEAMS computer model predictions with field data for alachlor, metribuzin, and norflurazon leaching. Environ Toxicol Chem. 11: 427-436.

Ontario Ministry of Agriculture. 2000. Universal Soil Loss Equation (USLE) Factsheet. Agdex No. 572/751. Publication Date: May, 2000. Available at: http://www.omafra.gov.on.ca/english/engineer/facts/00-001.htm#tab2..

Paroscientific Inc. 2003. MET3A Calculation of Dew Point. http://www.paroscientific.com/dewpoint.htm.

Parrish RS; Smith CN; Fong FK. 1992. Tests of Pesticide Root Zone Model and the Aggregate Model for Transport and Transformation of aldicarb, metolachlor, and bromide. J Environ Qual. 21: 685-697.

Penman HL. 1948. Natural evaporation from open water, bare soil and grass. Proc. Royal Soc., London. A193: 120-145.

Renard, K.G., G.R. Foster, G.A. Weesies, D.K. McCool, and D.C. Yoder, coordinators. 1997. Predicting Soil Erosion by Water: A Guide to Conservation Planning With the Revised Universal Soil Loss Equation (RUSLE). U.S. Department of Agriculture, Agriculture, Handbook No. 703, 404 pp. Available at: http://www.ott.wrcc.osmre.gov/library/ hbmanual/rusle703.htm.

Romkens MJM; Young RA; Poesen JWA; McCool DK; El-Swaify SA; Bradford JM. 1997. Chapter 3. Soil Erodibility Factor (K). In: Renard et al. 1997.

SERA (Syracuse Environmental Research Associates, Inc.). 1999. Imazapyr (Arsenal, Chopper, and Stalker Formulations) Final Report. SERA TR 98-21-14-01b, dated February 26, 1999. Task No.14, USDA/FS Contract No. 53-3187-5-12, USDA/FS Order No. 43-3187-8-0222.

SERA (Syracuse Environmental Research Associates, Inc.). 2000. Documentation for the Use of GLEAMS and Auxiliary Programs in Forest Service Risk Assessments. SERA AT 2000-01b,

dated September 24, 2000.

SERA (Syracuse Environmental Research Associates, Inc.). 2004. Documentation for the Use of GLEAMS (Version 3) and Auxiliary Programs in Forest Service Risk Assessments (Version 2.04), SERA TD 2004-02.04a, dated February 8, 2004. Available at: www.sera-inc.com.

SERA (Syracuse Environmental Research Associates, Inc.). 2005. Documentation for Worksheets Version 4.01 - Human Health and Ecological Risk Assessments. Report dated May 4, 2005. Available at: www.sera-inc.com.

SERA (Syracuse Environmental Research Associates, Inc.). 2006a. Modifications to Gleams-Driver Version 1: Default Values for Soil Organic Matter. SERA TR-052-05-03b, dated Nov. 16, 2006. Available at: www.sera-inc.com.

SERA (Syracuse Environmental Research Associates, Inc.). 2006b. Modifications to Gleams-Driver Version 1: Augmentation of Chemical Database. SERA TR-052-05-01b, dated Aug. 5, 2006. Available at: www.sera-inc.com.

SERA (Syracuse Environmental Research Associates, Inc.). 2006c. Modifications to Gleams-Driver Version 1: Expanded Weather Files. SERA TR-052-05-04a, dated Dec. 17, 2006. Available at: www.sera-inc.com.

SERA (Syracuse Environmental Research Associates, Inc.). 2006d. Modifications to Gleams-Driver Version 1: Linking to WorksheetMaker. SERA TR-052-05-04a, dated Dec. 17, 2006. Available at: www.sera-inc.com.

Sichani SA; Engel BA; Monke EF; Eigel JS; Kladivko EJ. 1991. Validating GLEAMS with pesticide field data. Trans Amer Soc Agr Engineers. 34(4): 1732-1737.

Smith MC; Bottcher AB; Campbell KL; Thomas DL. 1991. Field testing and comparison of the PRZM and GLEAMS models. Trans Amer Soc Agr Engineers. 34(3): 838-847.

Terzi O; Keskin ME. 2005. Modeling of daily pan evaporation. J Appl. Sciences. 5(2): 368-372.

Truman CC; Leonard RA. 1991. Effects of pesticide, soil, and rainfall characteristics on potential pesticide loss by percolation – A GLEAMS Simulation. Trans Amer Soc Agr Engineers. 34(6): 2461-2468.

USDA/NSERL (United States Department of Agriculture/National Soil Erosion Research Laboratory). 2004. Cligen Weather Generator, expanded and improved by USDA Agricultural Research Service and U. S. Forest Service. Available at: http://horizon.nserl.purdue.edu/Cligen/

Weber JB. 1994. Properties and behavior of pesticides in soil. In: Mechanisms of Pesticide

Movement Into Ground Water. Honeycutt, R.C. & Schadebacker, D.J. (editors). Ann Arbor, MI: Lewis Publ, CRC Press, Inc., pp. 15-41.

Winegardner DL. 1996. An Introduction to Soils for Environmental Professionals. CRC Press, Boca Raton, Florida. 270 pp.

Wischmeir WH. 1978. Predicting rainfall erosion losses: a Guide to Conservation Planning. USDA Agriculture Handbook No. 537. 58 pp.

Table 1: Precipitation, Temperature and Classifications for Standard Test Sites

Location	Precipitation	Temperature	Average Annual Rainfall (inches)	Average Annual Temperature (°F)
HI, Hilo	Wet	Warm	126.06	73.68
WA, Quillayute [1]	Wet	Temperate	95.01	49.14
NH, Mt. Washington	Wet	Cool	98.49	27.12
FL, Key West	Average	Warm	37.68	77.81
IL, Springfield	Average	Temperate	34.09	52.79
MI, Sault Ste. Marie	Average	Cool	32.94	40.07
AR, Yuma Test Station	Dry	Warm	3.83	73.58
CA, Bishop	Dry	Temperate	5.34	56.02
AK, Barrow	Dry	Cool	4.49	11.81

[1] Based on composite estimation in WEPP using a latitude of 47.94 N and a longitude of -124.54 W. See SERA (2006c) for details.

Table 2: Default soil properties currently used in Gleams-Driver [1]

Soil texture classification	BD	POR	FC	BR15	CONA	%Clay	% Silt	% Sand	KSOIL[2]	OM % [2]
Coarse sand	1.6	0.4	0.11	0.03	3.3	5	5	90	0.1	1
Sand	1.6	0.4	0.16	0.03	3.3	5	5	90	0.02	1.2
Fine sand	1.5	0.43	0.18	0.03	3.3	5	5	90	0.08	1
Very fine sand	1.5	0.43	0.27	0.03	3.3	5	5	90	0.43	1.5
Loamy coarse sand	1.6	0.4	0.16	0.05	3.3	8	8	84	0.03	2
Loamy sand	1.6	0.4	0.19	0.05	3.3	8	8	84	0.04	2.4
Loamy fine sand	1.6	0.4	0.22	0.05	3.3	8	8	84	0.11	1
Loamy very fine sand	1.6	0.4	0.37	0.05	3.3	8	8	84	0.39	1.5
Coarse sandy loam	1.6	0.4	0.19	0.08	3.3	15	25	60	0.07	2
Sandy loam	1.6	0.4	0.22	0.08	3.5	15	25	60	0.13	2.3
Fine sandy loam	1.7	0.36	0.27	0.08	3.5	15	25	60	0.18	2.5
Very fine sandy loam	1.6	0.4	0.37	0.08	3.5	15	25	60	0.39	2.7
Loam	1.6	0.4	0.26	0.11	4.5	20	35	45	0.3	2.9
Silt loam	1.5	0.43	0.32	0.12	4.5	20	60	20	0.38	3.4
Silt	1.4	0.47	0.27	0.13	4	10	85	5	0.73	1
Sandy clay loam	1.6	0.4	0.3	0.18	4	25	20	55	0.2	2.9
Clay loam	1.6	0.4	0.35	0.22	4	35	30	35	0.3	3.2
Silty clay loam	1.4	0.47	0.36	0.2	4	35	50	15	0.32	4
Sandy clay	1.6	0.4	0.28	0.2	3.5	40	10	50	0.13	3.5
Silty clay	1.5	0.43	0.4	0.3	3.5	45	45	10	0.26	2.5
Clay	1.4	0.47	0.39	0.28	3.5	50	30	20	0.24	3.7
Volcanic pumice [4]	0.8	0.7	0.58	0.38	3.5	40	40	10	0.35	12.0
Muck [4]	0.3	0.89	0.4	0.18	3.5	100	--	--	0.10	80.0
Peat [4]	0.2	0.92	0.75	0.6	3.5	100	--	--	0.05	80.0

[1] Unless otherwise specified, all values are taken from the documentation for GLEAMS (Knisel and Davis 2000). See Table 3 on the next page for a key to the column abbreviations and more specific references to the GLEAMS documentation.

[2] Values for KSOIL taken from Ontario Ministry of Agriculture (2000) except for coarse sand, loamy course sand, and silt. Value for silt based on algorithm in Knisel and Davis (2000). Values for coarse sand are set by analogy to sandy loam and course sandy loam. Value for loamy course sand are set intermediate to loamy sand and sand.

[3] The values for OM are based on the average values from data listed in the USDA/ARS pesticides properties database. See SERA (2006a) for additional details.

[4] See Appendix 3 for discussion of volcanic and organic soils.

Table 3: Data sources, codes, and constraints for soil properties listed in Table 2.

Parameter	**Code for Access Database [Constraints [1]]**	**Source**
Soil erodibility factor	KSOIL	GLEAMS documentation, pp. 74 to 75.
Bulk density (g/cc)	BD	GLEAMS documentation, Table H-3, p. 46. Note: GLEAMS and Gleams-Driver impose the following additional relationships: BR15 < FC < POR < 1
Porosity (cc/cc)	POR [0.2 to 0.9]	
Field capacity (cm/cm)	FC [0.1 to 0.5]	
Wilting point (cm/cm)	BR15 [0.01 to 0.4]	
Evaporation constant (mm/d)	CONA [3.3 to 4.5]	
Percent Clay	CLAY	GLEAMS documentation, Table H-5, p. 48.
Percent Silt	SILT	
Percent Sand	SAND	
SCS Runoff Curve Number	CN2 [1 99]	See Table 5 for values and sources.
Percent Organic Matter	OM	Derived from data in USDA/ARS Pesticides Properties Database. See SERA 2006a.

[1] GLEAMS requires that CLAY + SILT ≤ 100. This constraint as well as the constraints given above are enforced internally by Gleams-Driver and cannot be over-ridden. Other constraints are judgmental but are intended to reflect plausible ranges. These constraints cannot be overridden.

Table 4: Saturated Conductivity Values Used fro Different Hydrologic Soil Groups [1].

Group	Description	Saturated Conductivity (RC and SATK) inches/hour	
		Lower	Upper
A	Low runoff potential: Soils having high infiltration rates even when thoroughly wetted and consisting chiefly of deep, well to excessively drained sands or gravels. These soils have a high rate of water transmission.	0.30	5.0 (SATK) 0.5 (RC)
B	Moderate water transmission: Soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately coarse textures. These soils have a moderate rate of water transmission.	0.15	0.3
C	Slow water transmission: Soils having slow infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. These soils have a slow rate of water transmission.	0.05	0.15
D	High runoff potential: Soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. The soils have a very slow rate of water transmission.	0.005	0.05

[1]Adopted from Table H-2 in Knisel and Davis (2000, p. 46). See Table 4 for runoff curve numbers based on land use. In Gleams-Driver, RC is constrained to be between 0.001 and 0.75 and SATK is constrained to be between 0.001 and 5. These constraints cannot be overridden but future versions of Gleams-Driver may offer a mechanism to override these values.

Table 5: Runoff curve numbers (CN2) for hydrologic soil groups based on different land uses [1]

Land Use	Hydrologic condition	Group A			Group B			Group C			Group D		
		L	C	U	L	C	U	L	C	U	L	C	U
Meadow	NOS	51	59	66	67	74	78	79	82	84	85	86	87
Woods	poor	33	45	55	56	66	71	72	77	80	81	83	85
Woods	fair	22	36	48	49	60	66	67	73	76	77	79	81
Woods	good	8	25	41	42	55	62	63	70	73	74	77	80
Road	Dirt	66	72	77	78	82	84	85	87	88	88	89	90
Road	Hard surface	68	74	79	80	84	87	88	90	91	91	92	93

[1] Ranges of values specified by the following abbreviations: L=lower, C=central, U=upper. Values taken from Knisel and Davis (2006). In the current version of Gleams-Driver, CN2 is constrained to be between 1 and 99. This constraint cannot be overridden in the current version of Gleams-Driver but future versions of Gleams-Driver may offer a mechanism to override the constraints.

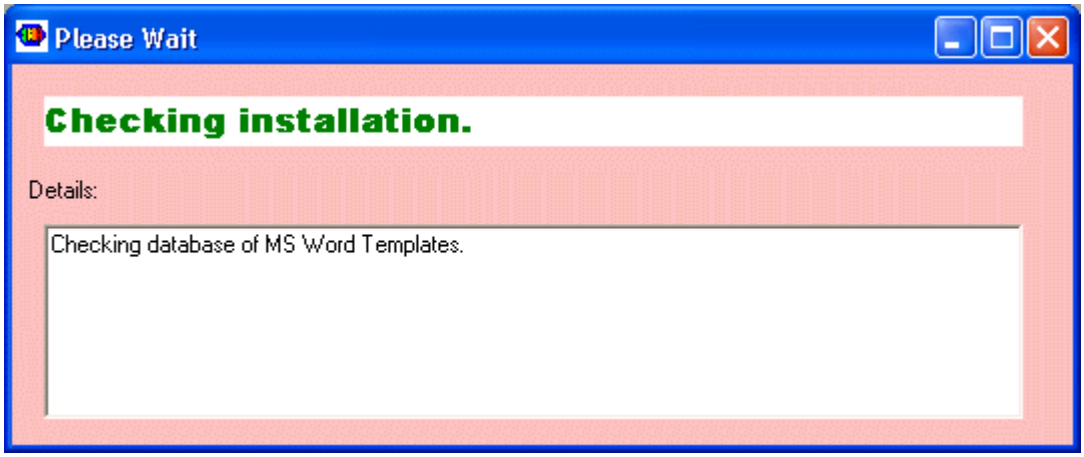


Figure 1: Check Installation Screen

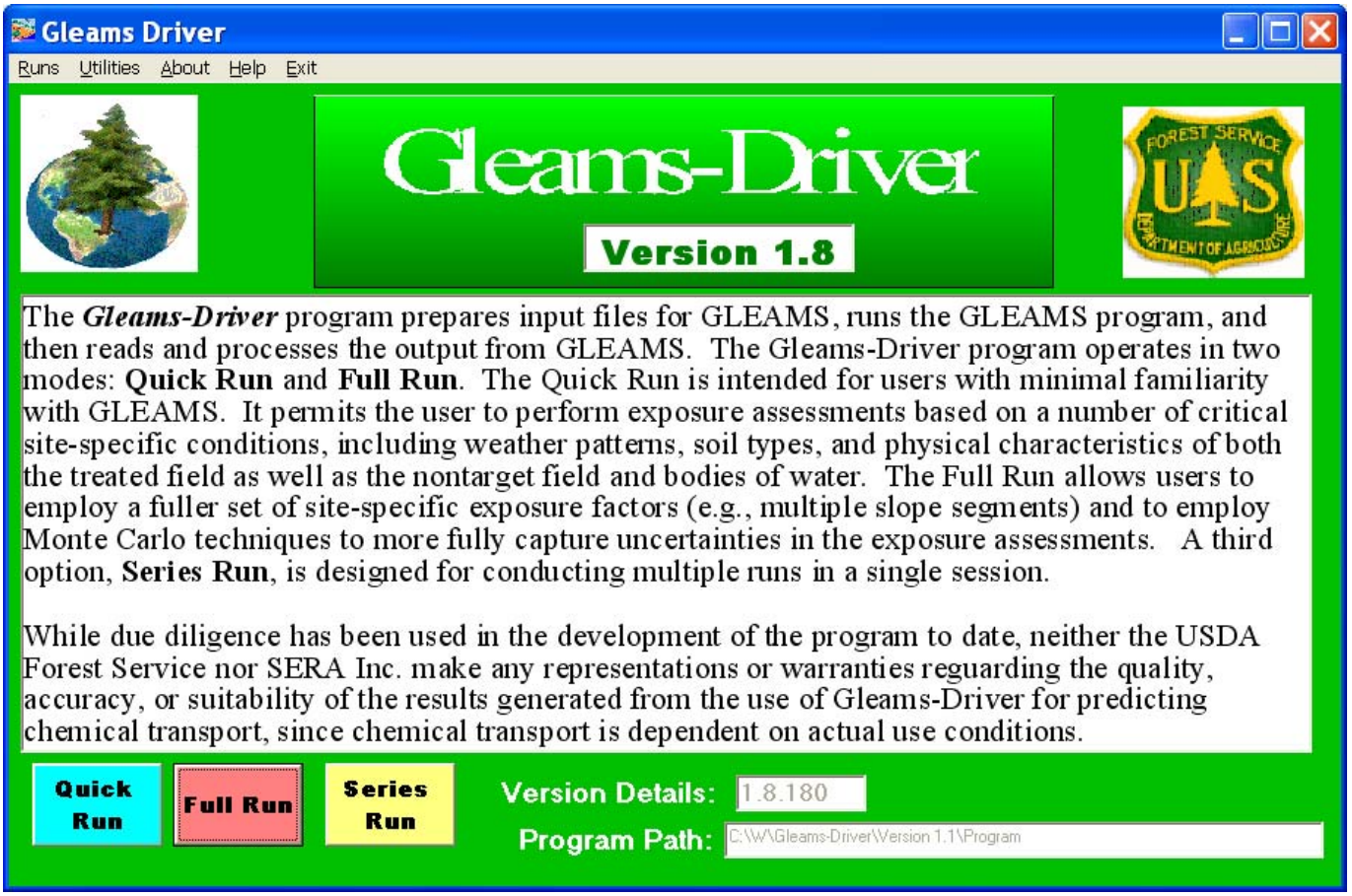


Figure 2: Gleams-Driver Main Program Screen

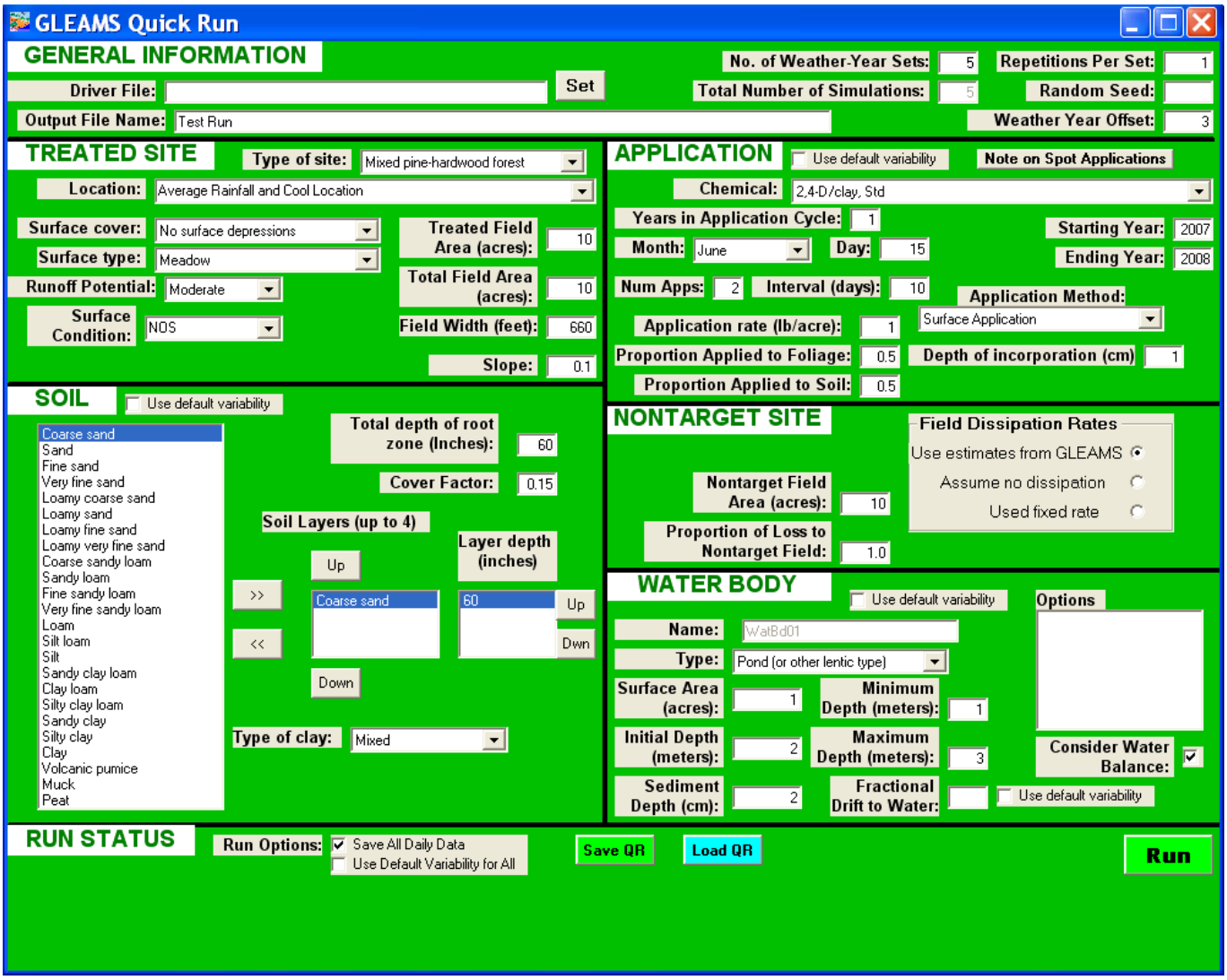


Figure 3: Quick Run Screen

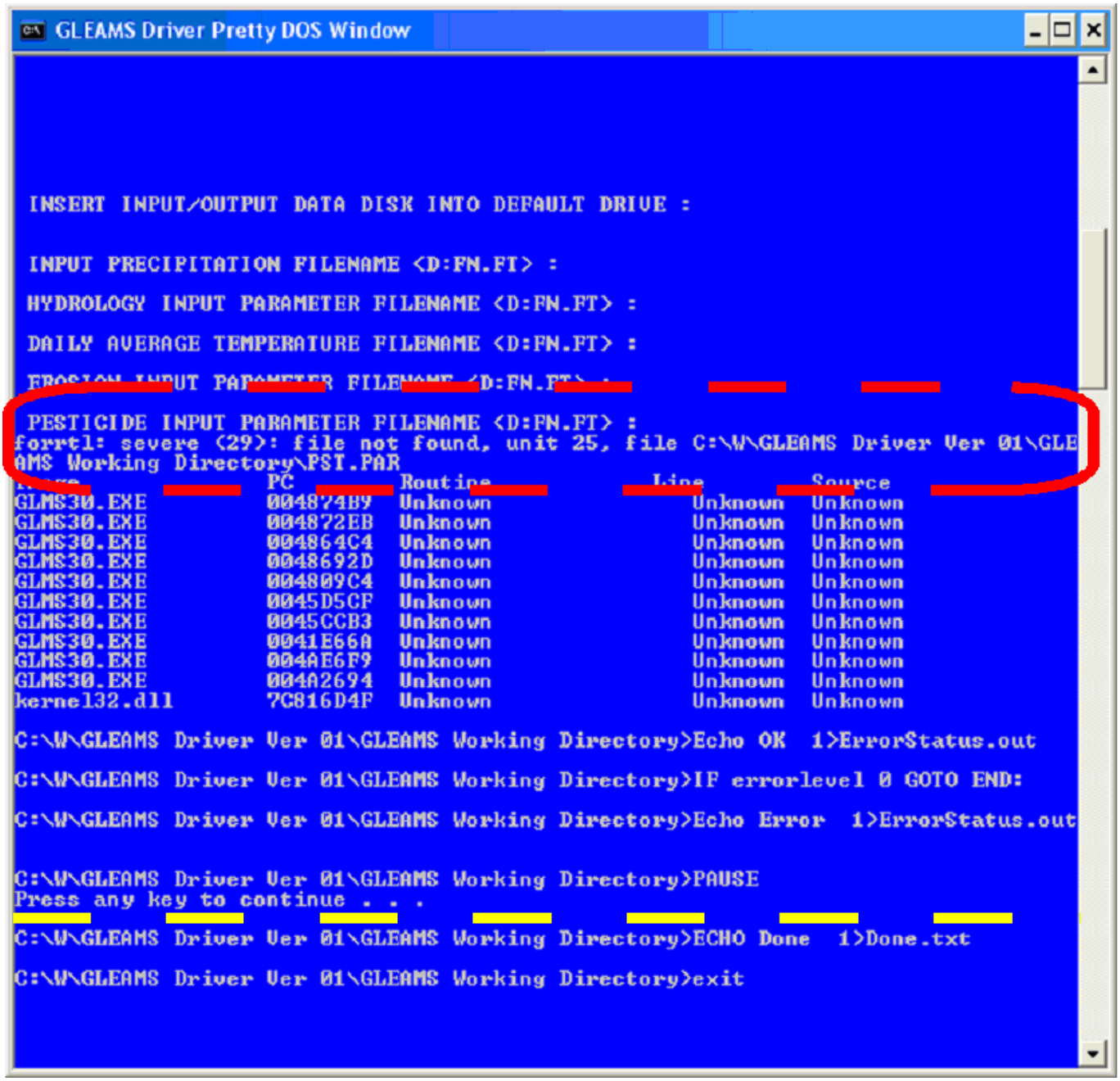


Figure 4: Error in GLEAMS Run

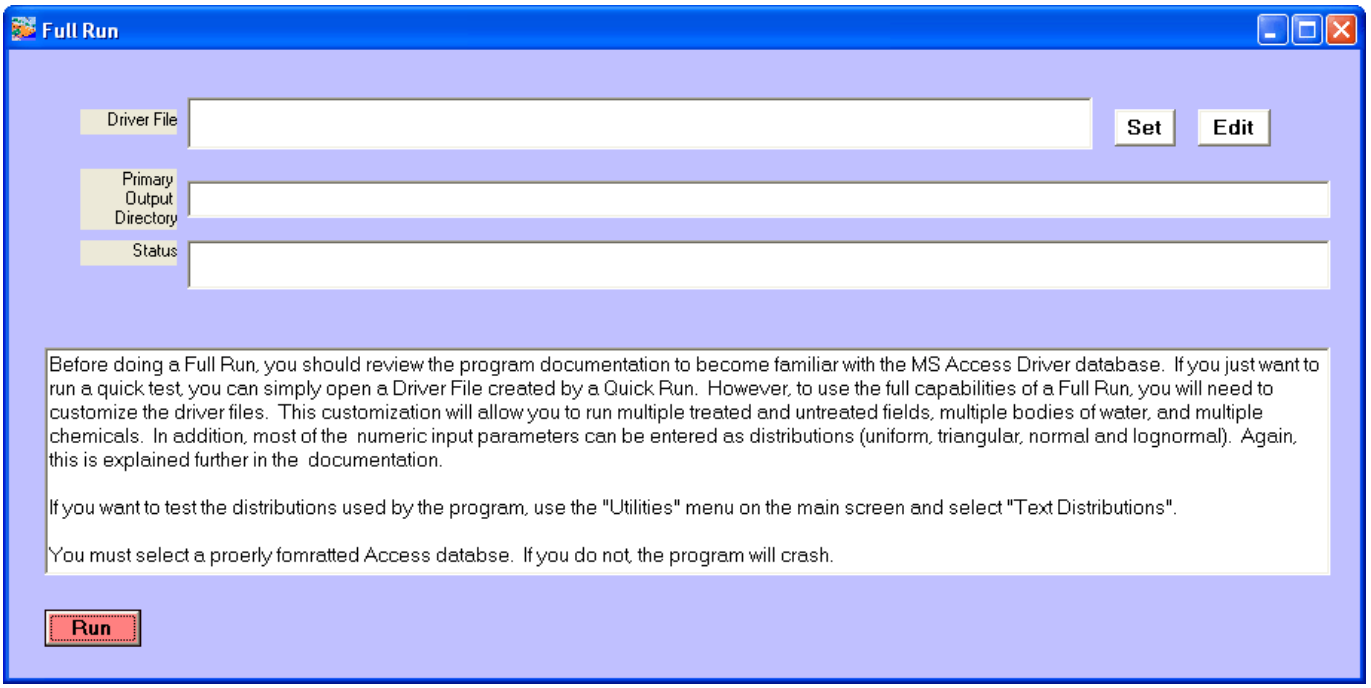


Figure 5: Full Run Screen

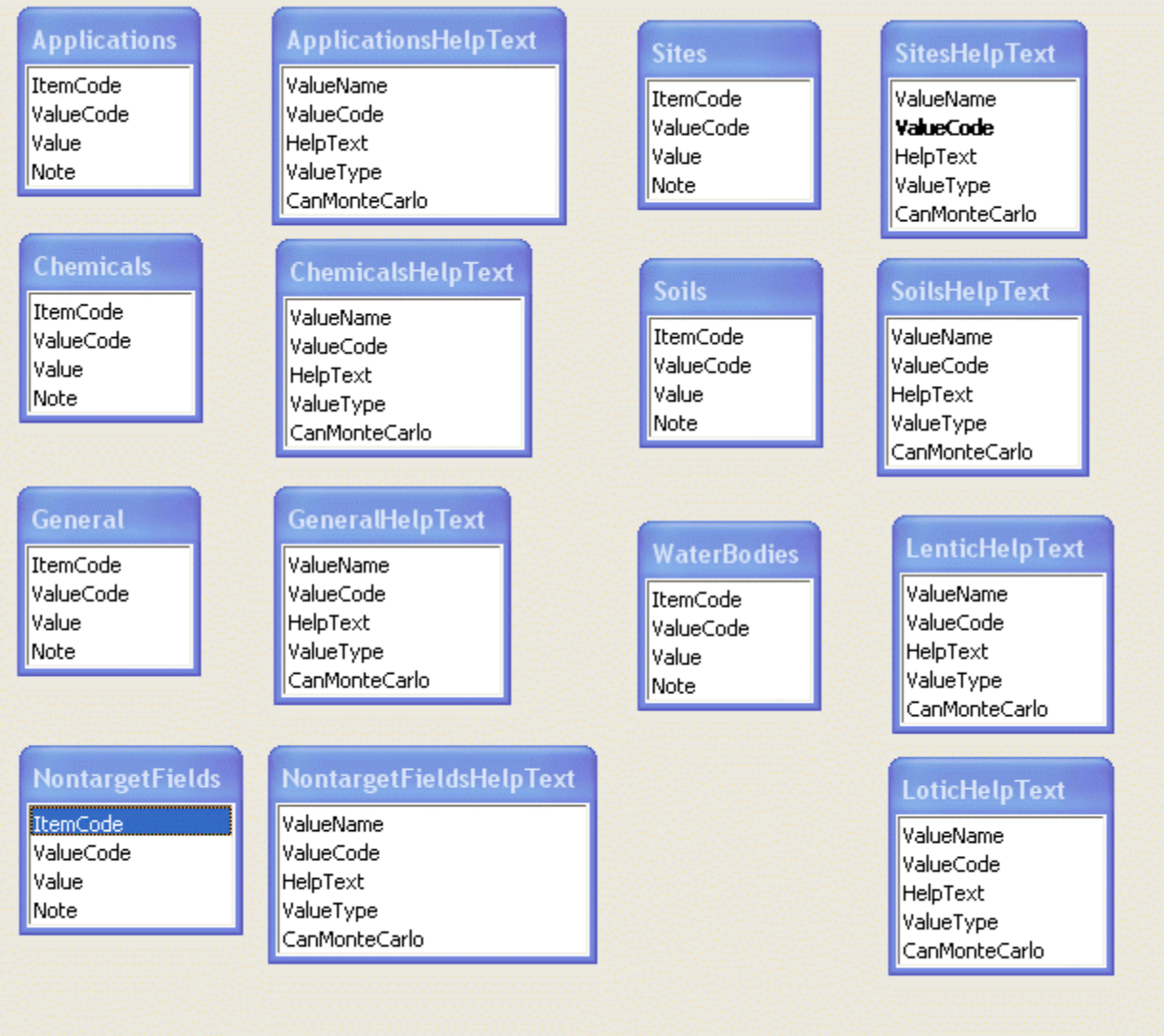


Figure 6: Structure of Access Input file template

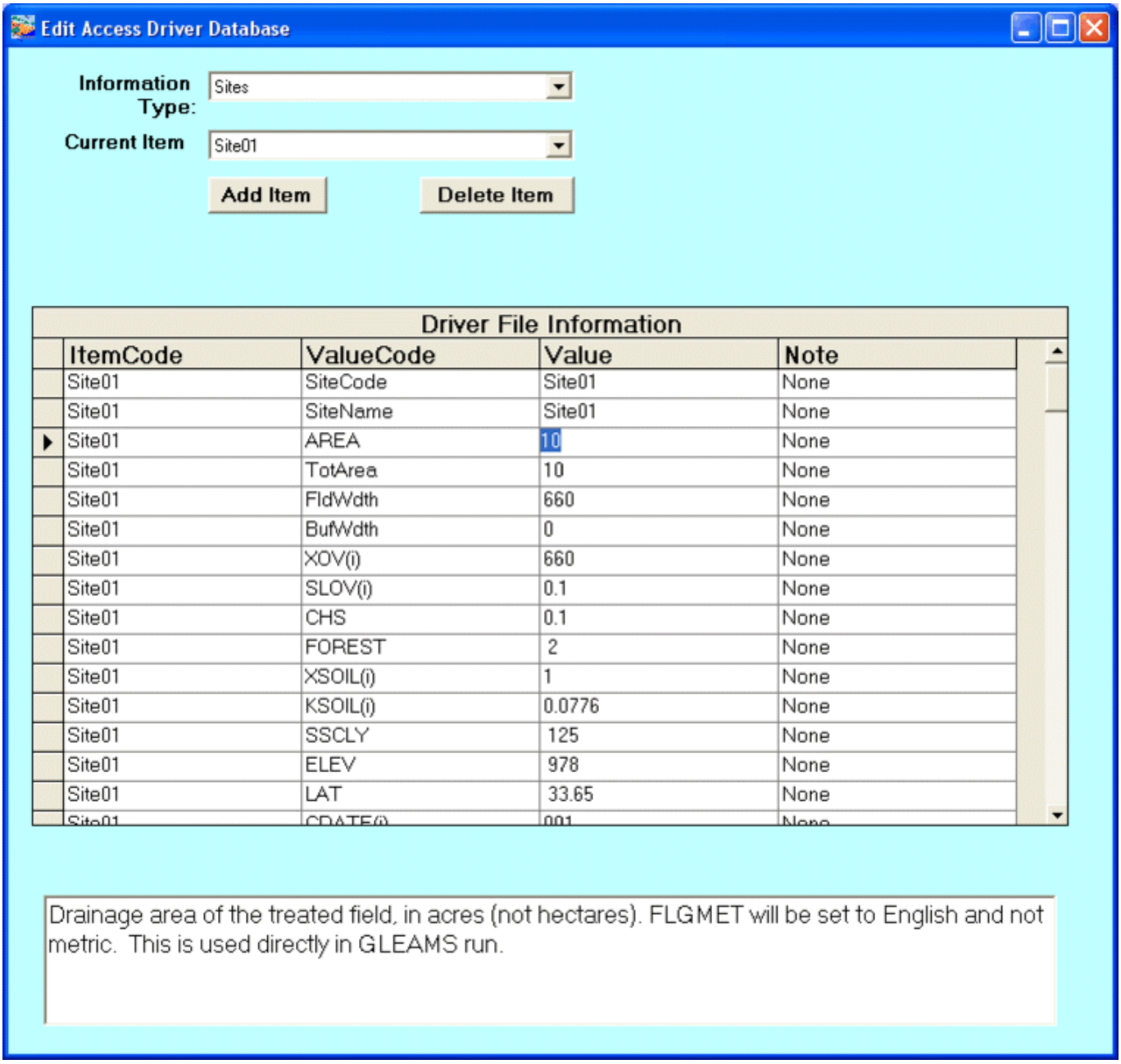
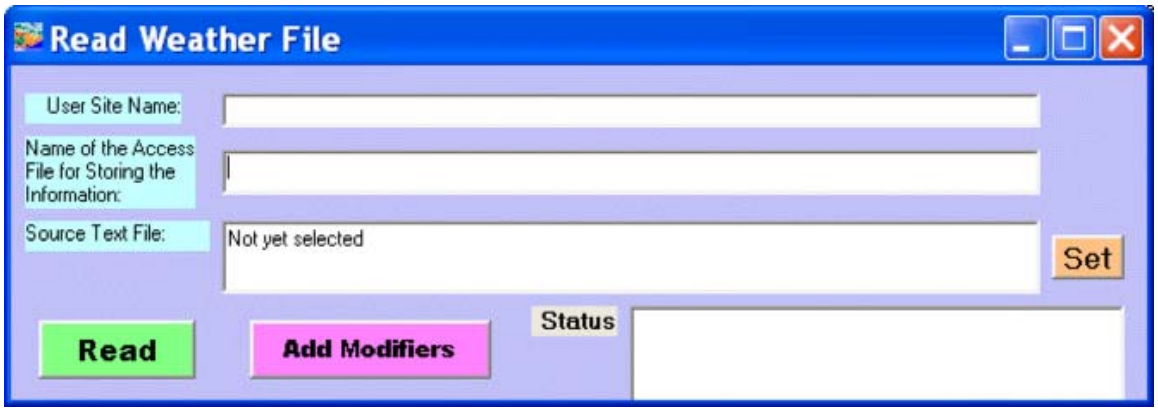


Figure 7: Edit window for a Full Run

A. Simple Import



B. Import with Modifiers

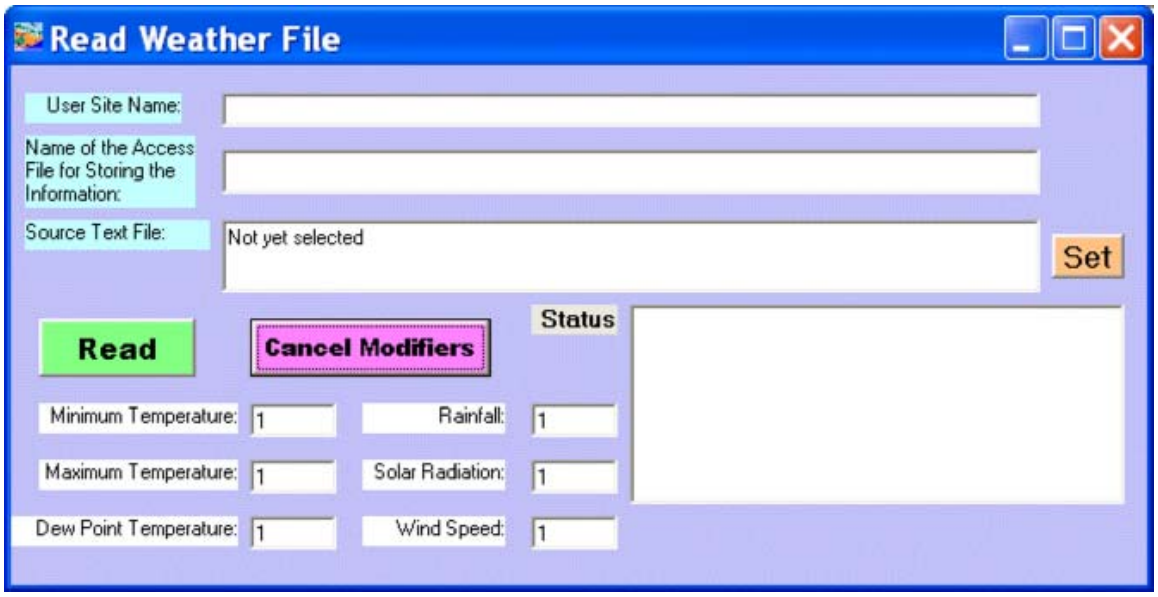


Figure 8: Utility screen for importing Cligen weather files

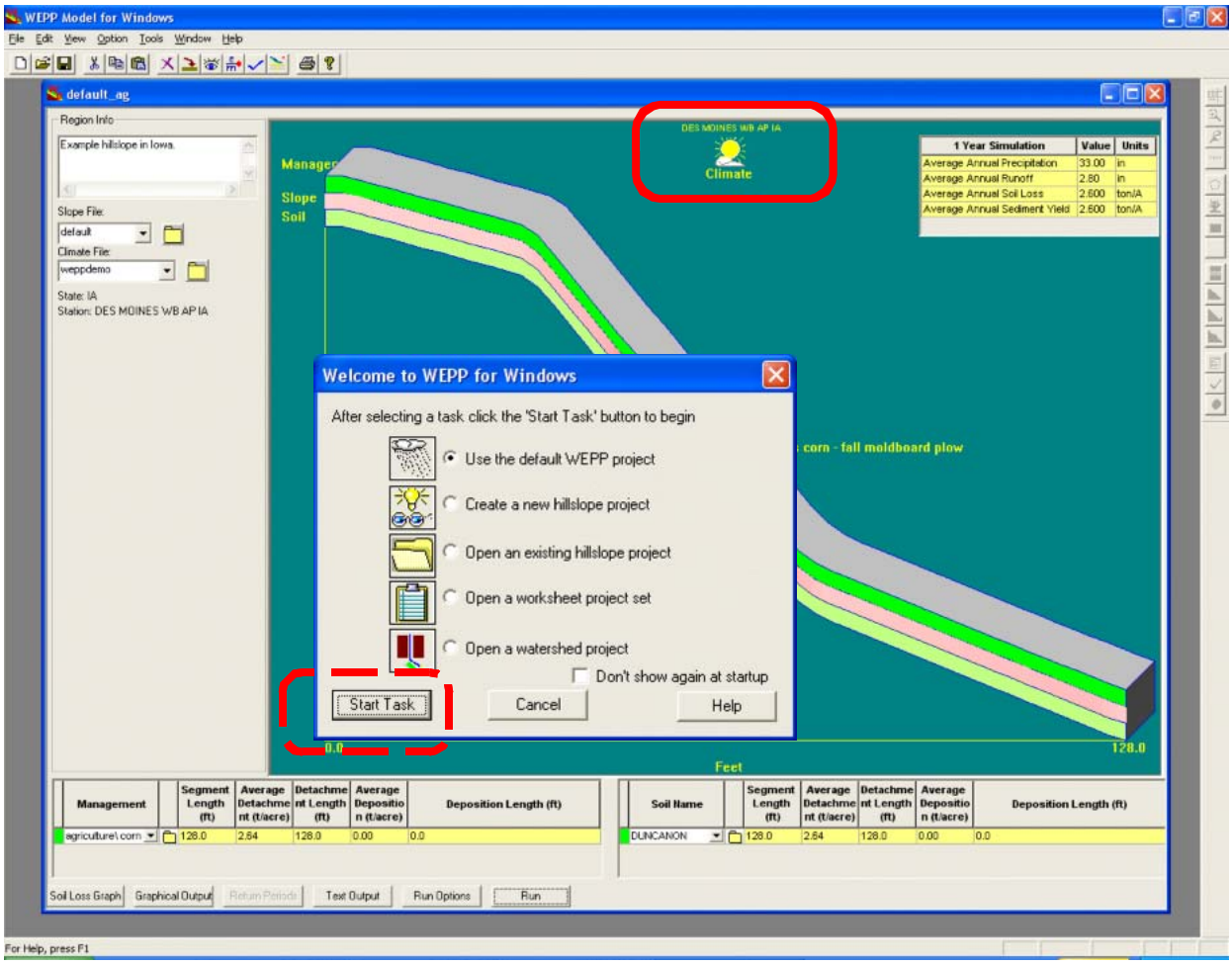


Figure 9: Main screen in WAPP

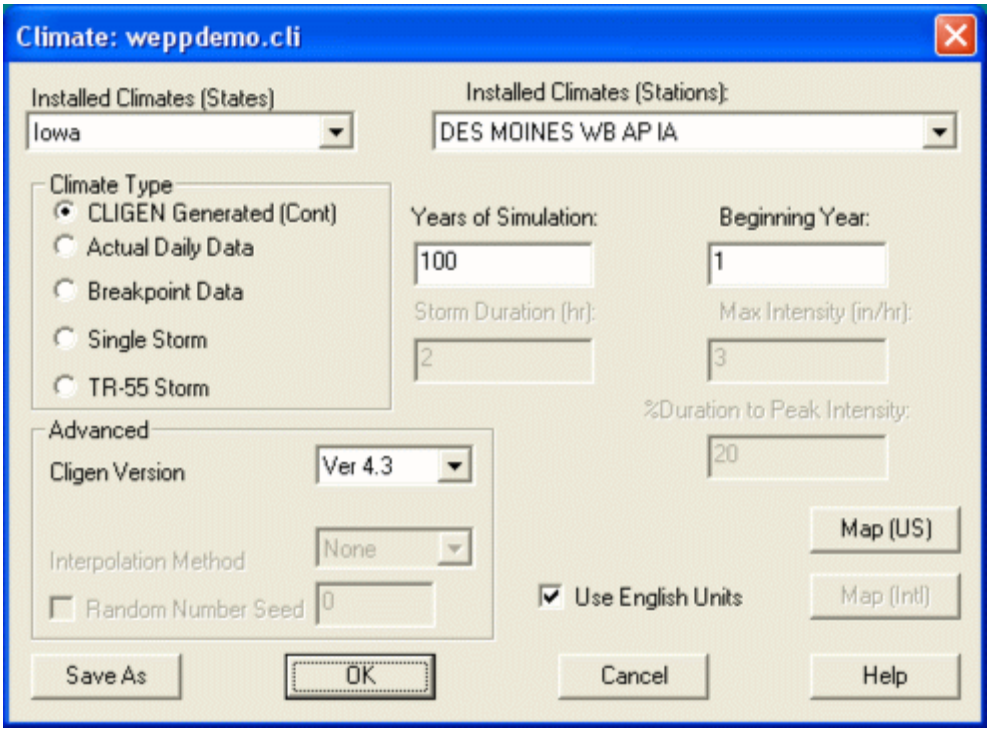


Figure 10: Site selection screen in WEPP

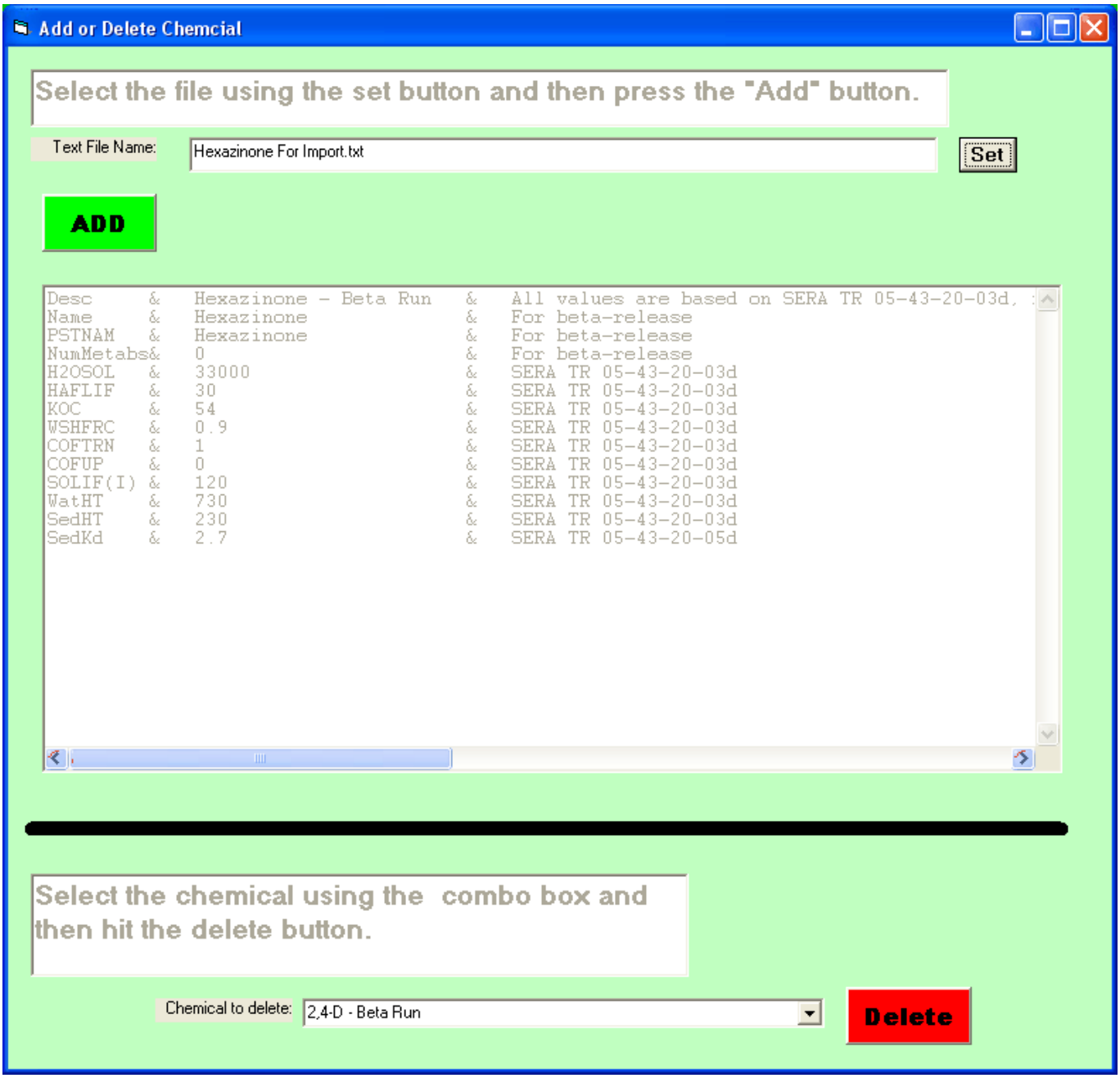


Figure 11: Form for adding and deleting chemicals

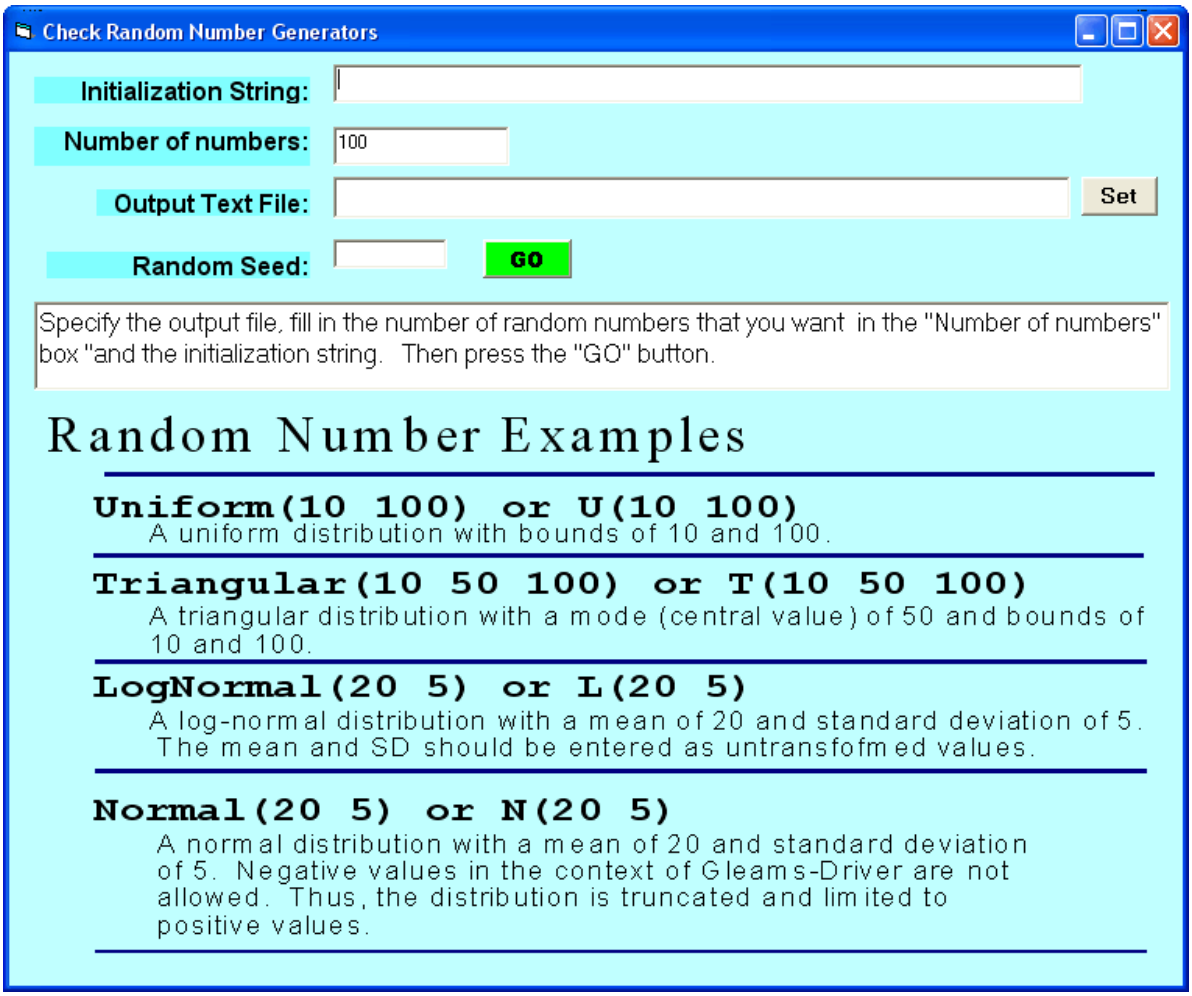


Figure 12: Check random number form

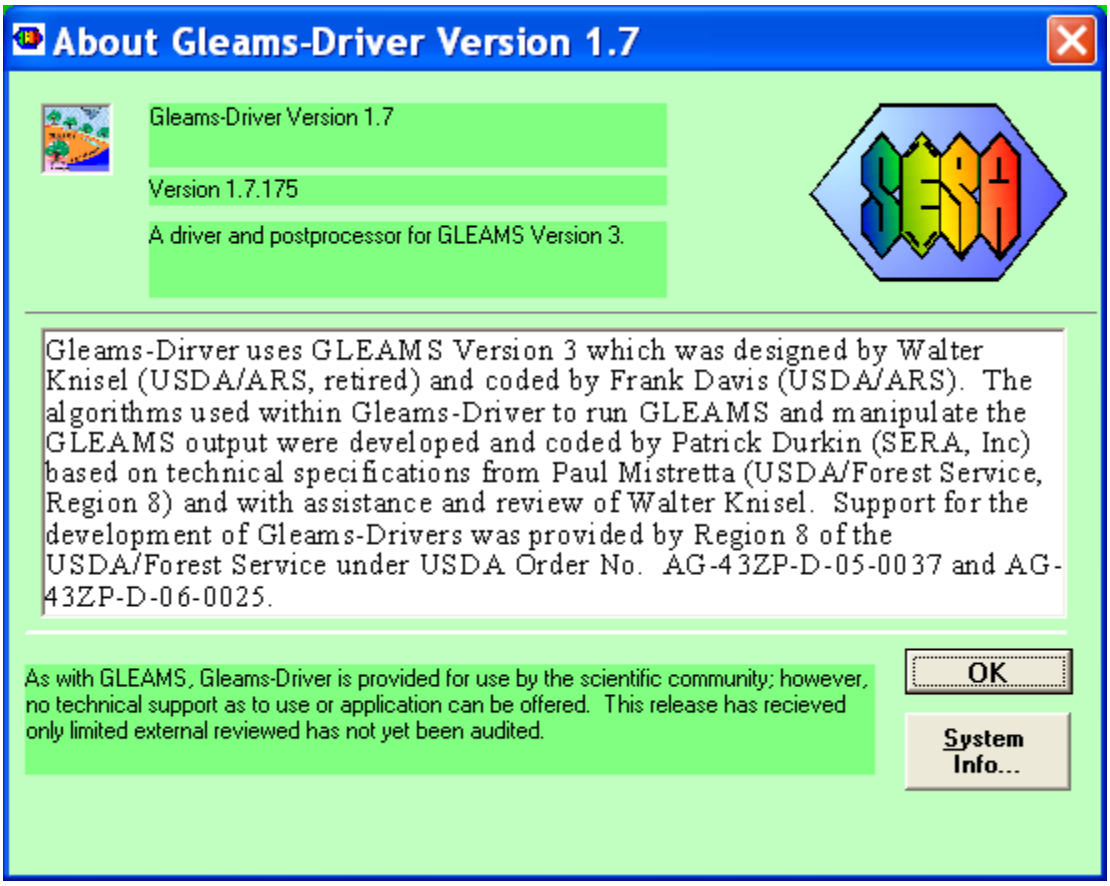


Figure 13: About window for Gleams-Driver

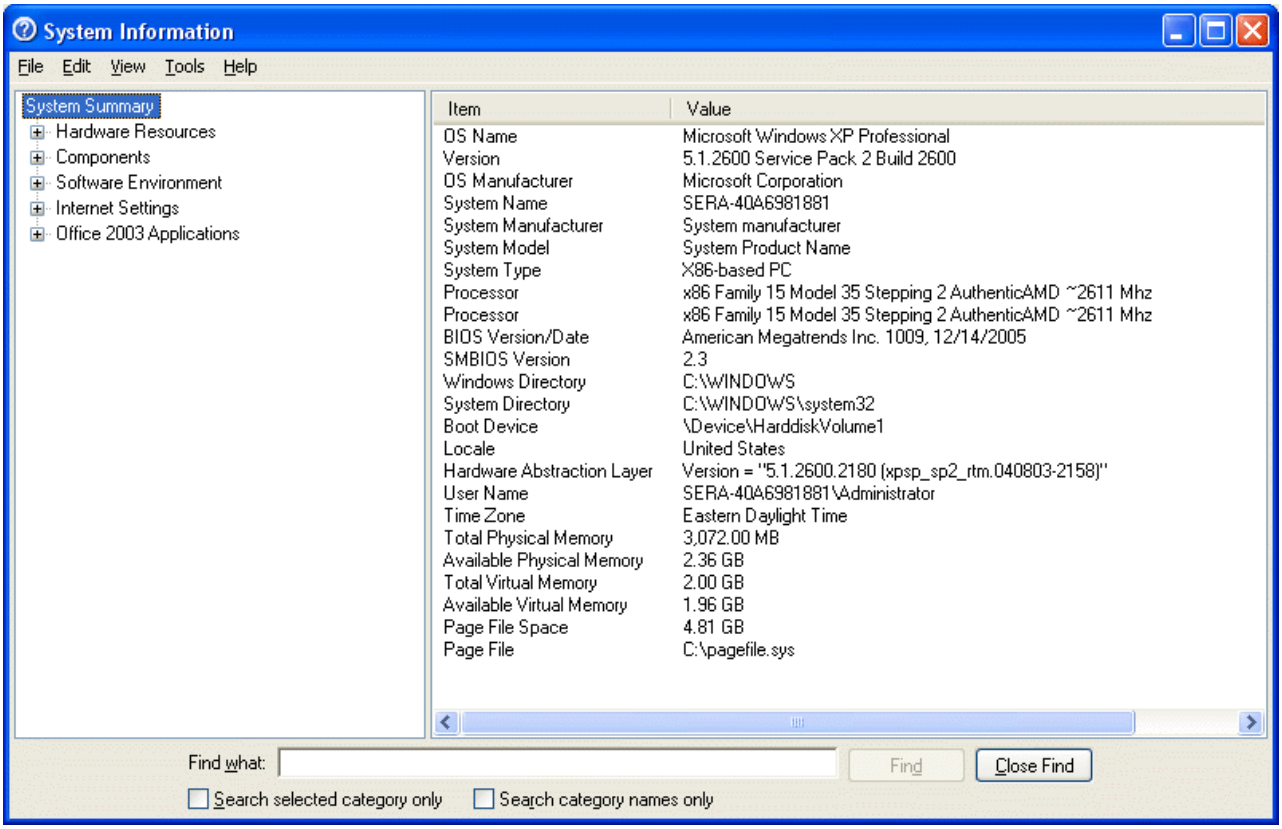


Figure 14: System Information Window

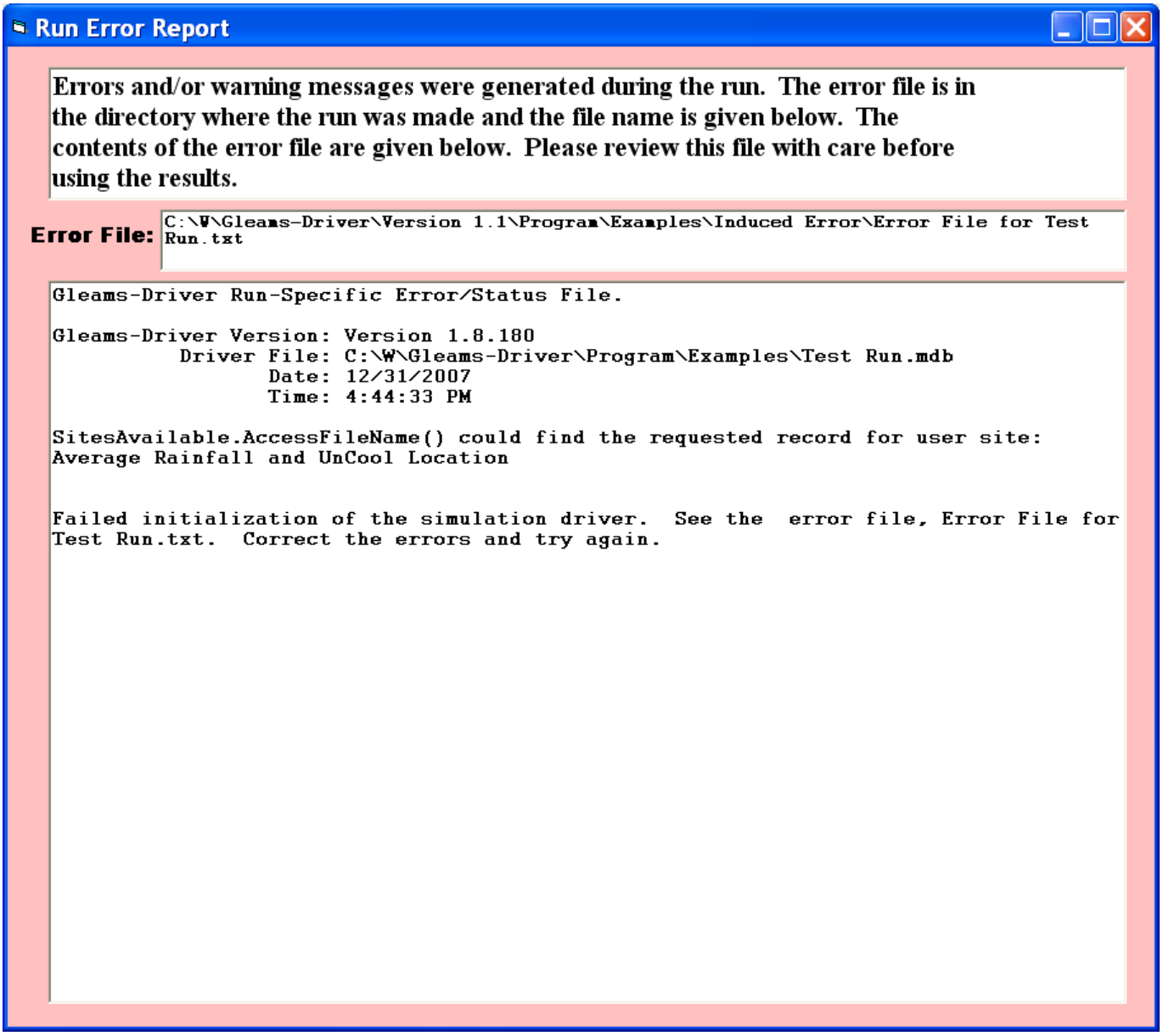


Figure 15: Error Report from Gleams-Driver

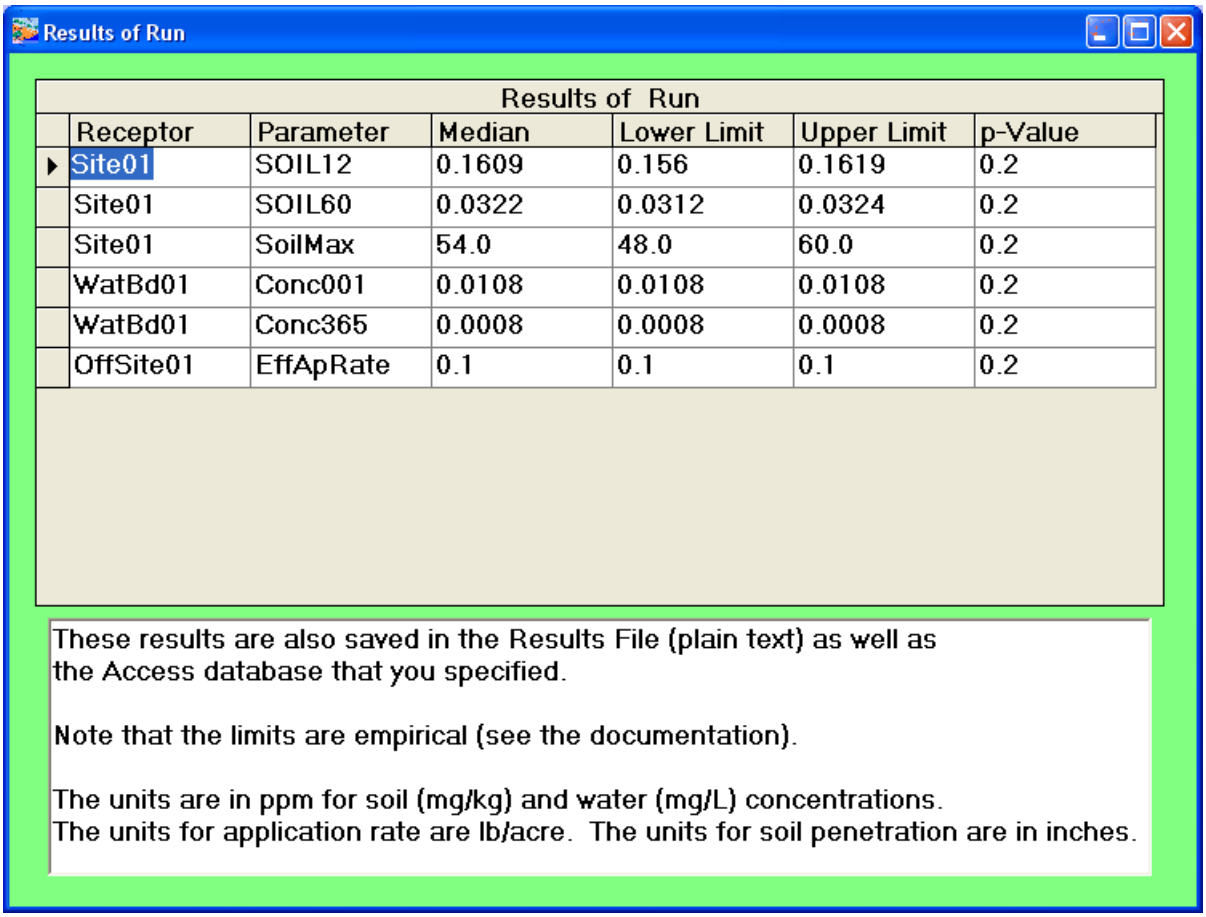


Figure 16: Results summary window displayed after a Quick Run

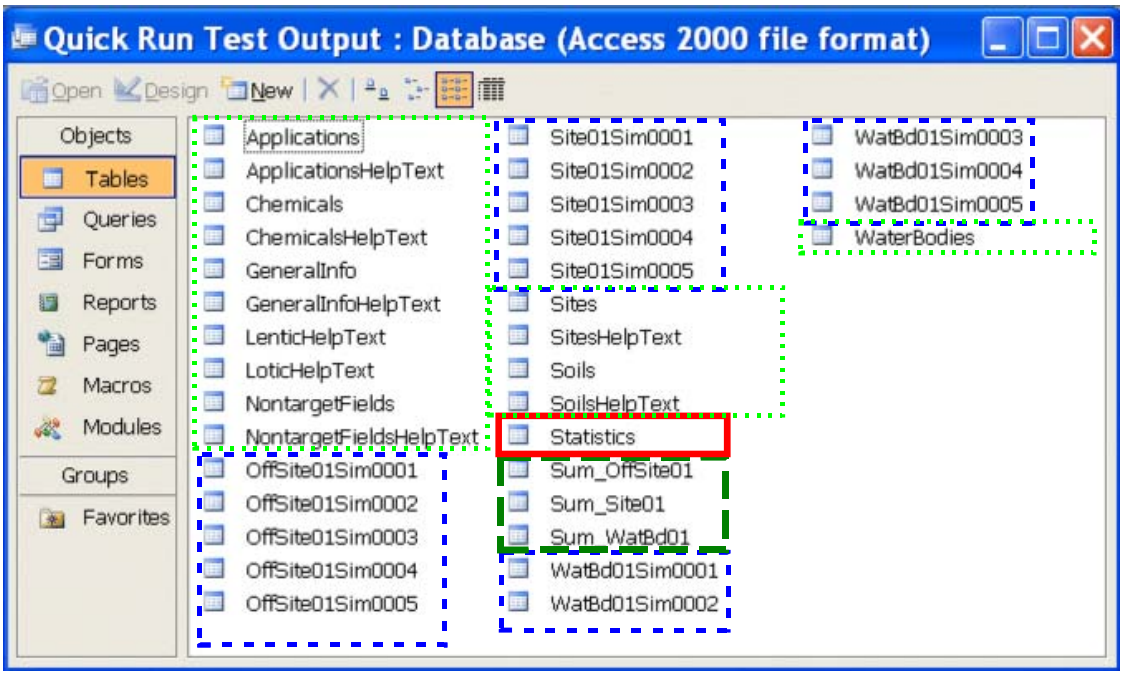


Figure 17: Sample Access Output Database from a Quick Run

Site01Sim0001 : Table

ThisDate	JDAY	Cd00001	Cd00002	Cd00003	Cd00022	Cd10001	Cd11001	Cd12001	Cd13001	Cd1400	Cd15001	Cd18001	SOIL12	SOIL60	SoilMax	SoilKe
8/11/2008	2008224	0.68	0	0.117753	70.5	0	0	0	0	0	0	0.001086	0.00155	0.000311	18	0.09818
8/12/2008	2008225	0	0	0	76.6	0	0	0	0	0	0	0.001446	0.00139	0.000278	8	0.11323
8/13/2008	2008226	0	0	0	69.80000	0	0	0	0	0	0	0.002080	0.00125	0.00025	8	0.10686
8/14/2008	2008227	0	0	0	72.5	0	0	0	0	0	0	0.002403	0.00112	0.000225	8	0.104
8/15/2008	2008228	0	0	0	76.90000	0	0	0	0	0	0	0.002790	0.00102	0.000204	8	0.09595
8/16/2008	2008229	0	0	0	75.7	0	0	0	0	0	0	0.003113	0.00094	0.000188	8	0.08195
8/17/2008	2008230	0	0	0	75.90000	0	0	0	0	0	0	0.003154	0.00087	0.000175	8	0.07365
8/18/2008	2008231	0	0	0	77.30000	0	0	0	0	0	0	0.002957	0.00081	0.000162	8	0.07504
8/19/2008	2008232	0.01	0	0	80.2	0	0	0	0	0	0	0.002677	0.00075	0.00015	8	0.07889
8/20/2008	2008233	0.06	0	0	76.7	0	0	0	0	0	0	0.002073	0.00069	0.000137	8	0.08708
8/21/2008	2008234	0	0	0	69.40000	0	0	0	0	0	0	0.001941	0.00063	0.000126	8	0.08357
8/22/2008	2008235	0	0	0	68.1	0	0	0	0	0	0	0.001982	0.00059	0.000117	8	0.07336
8/23/2008	2008236	0	0	0	71.5	0	0	0	0	0	0	0.001858	0.00055	0.000109	8	0.07305
8/24/2008	2008237	0	0	0	67.6	0	0	0	0	0	0	0.001742	0.00051	0.000102	8	0.07203
8/25/2008	2008238	0	0	0	71.90000	0	0	0	0	0	0	0.001633	0.00047	9.46E-05	8	0.07106
8/26/2008	2008239	0	0	0	66.1	0	0	0	0	0	0	0.001531	0.00044	8.83E-05	8	0.06953
8/27/2008	2008240	0	0	0	73.2	0	0	0	0	0	0	0.001436	0.00041	8.24E-05	8	0.06872
8/28/2008	2008241	0	0	0	74.40000	0	0	0	0	0	0	0.001346	0.00039	7.71E-05	8	0.06686
8/29/2008	2008242	0	0	0	60.40000	0	0	0	0	0	0	0.001262	0.00036	7.22E-05	8	0.06582
8/30/2008	2008243	0	0	0	73.90000	0	0	0	0	0	0	0.001183	0.00034	6.75E-05	8	0.06631
8/31/2008	2008244	0	0	0	71.1	0	0	0	0	0	0	0.001109	0.00032	6.33E-05	8	0.06447
9/1/2008	2008245	0	0	0	57.3	0	0	0	0	0	0	0.001040	0.0003	5.94E-05	8	0.06419
9/2/2008	2008246	0.13	0	0	70	0	0	0	0	0	0	0.000670	0.00027	5.40E-05	8	0.09468
9/3/2008	2008247	0.05	0	0	69.30000	0	0	0	0	0	0	0.000551	0.00024	4.9E-05	8	0.09794
9/4/2008	2008248	0	0	0	74.90000	0	0	0	0	0	0	0.000497	0.00022	4.45E-05	8	0.09607
9/5/2008	2008249	0	0	0	52.5	0	0	0	0	0	0	0.000481	0.00020	4.06E-05	8	0.09265
9/6/2008	2008250	0	0	0	60	0	0	0	0	0	0	0.000485	0.00015	3.06E-05	4	0.28217
9/7/2008	2008251	0	0	0	61.8	0	0	0	0	0	0	0.000484	0.00014	2.8E-05	4	0.08851

Record: 363 of 731

Figure 18: Sample Raw Data from Access Output Data Table

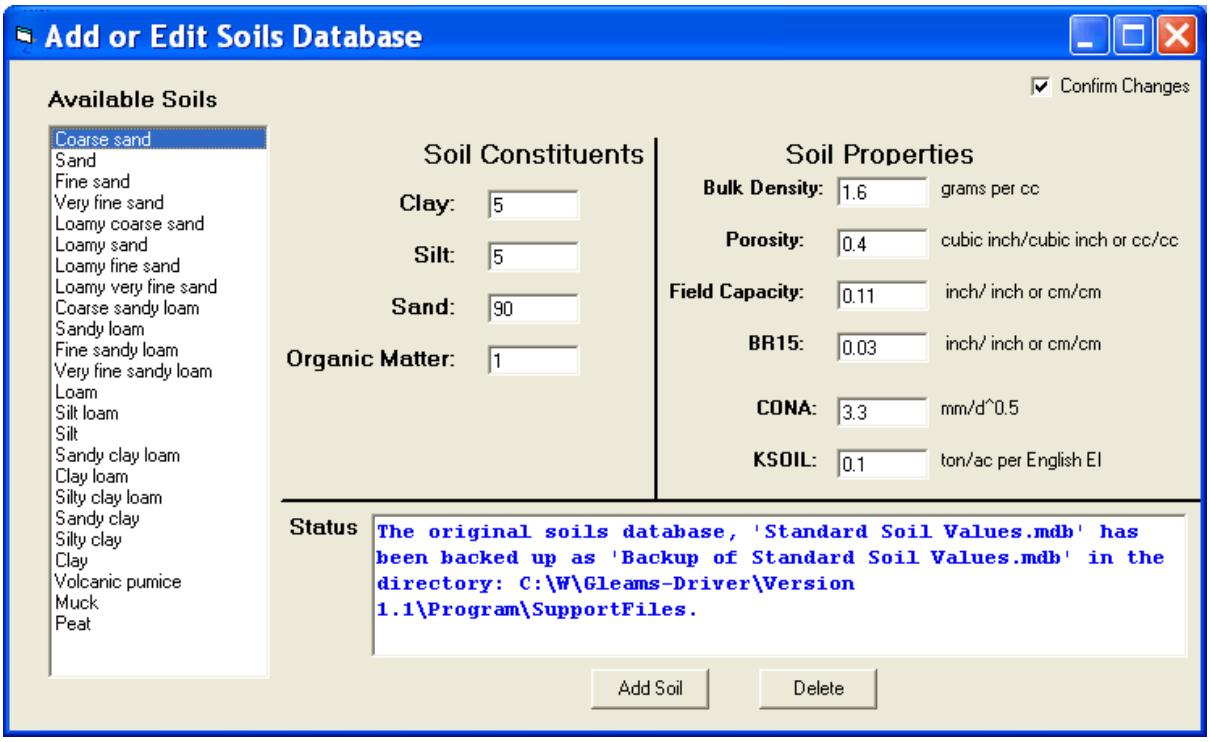


Figure 19: Add/Edit Soils Database Form

Appendix 1: Troubleshooting a Light Installation

Contacting your computer support staff is the best thing to do if you are having trouble installing Gleams-Driver or any other program. Some individuals in the Forest Service, however, have indicated that they are not able to get computer support because their computer support personnel will only provide assistance for certain programs – e.g., MS Office. The procedure described in this appendix has been developed in working with such individuals. The procedure is relatively simple and it may be useful to you if you are having installation problems. Some problems associated with successful installations but the subsequent failure of Gleams-Driver to run properly are detailed at the end of this appendix.

If you are having trouble doing a light installation, you should get an error message or a message telling you that you cannot install or do not have authorization to install one or more of the following files:

VB6STKIT.dll
msvbvm60.dll
oleaut32.dll
olepro32.dll
oleaut32.dll
comcat.dll
asycfilt.dll
stdole2.tlb

Write down the name or names that are causing the problem and proceed as recommended below.

All of the files listed above are runtime files that are required by any application that is created using Visual Basic 6.0 (SP6), the programming package that was used in creating *Gleams-Driver*. These files are created and distributed by Microsoft. Further information about these files can be found at:

http://msdn.microsoft.com/library/default.asp?url=/library/en-us/vbcon98/html/vbcondeterminingfilesyouneedtodistribute.asp

or

http://support.microsoft.com/default.aspx?scid=kb;en-us;290887.

The most likely reason that you are having trouble is that you already have a version of one or all of the above files on your PC and the settings of your Operating System (probably Windows 2000 Professional) are such that you do not have authorization to copy over the files that are installed on your PC.

If you already have these files on your PC, you probably do not need to reinstall these files even if your files are older than the ones that the Gleams-Driver installation package is trying to install. Thus, you need to tell the Gleams-Driver installation package to skip the file or files that are giving you trouble.

To do this, you must open **SETUP.LST**. As discussed in Section 2.2 of the documentation, **SETUP.LST** (as the name implies) is a list of files that is used to tell the setup program (**setup.exe**) which files should be installed on your PC. **SETUP.LST** is an ASCII text file that you can open with any text file editor. All versions of Windows come with a text file editor program called **NOTEPAD.EXE**. To open this program on most PCs with any version of Windows, use the following series of commands: **Start Programs Accessories NotePad**.

The top part of **SETUP.LST** is the only part of the file that you will need to work with. This part of the file is illustrated below:

```
[Bootstrap]
SetupTitle=Install
SetupText=Copying Files, please stand by.
CabFile=Gleams Driver Ver 1.8.CAB
Spawn=Setup1.exe
Uninstal=st6unst.exe
TmpDir=msftqws.pdw
Cabs=1
```

```
[Bootstrap Files]
File1=@VB6STKIT.DLL,$(WinSysPathSysFile),,,7/15/00 4:00:00 AM,101888,6.0.84.50
File2=@COMCAT.DLL,$(WinSysPathSysFile),$(DLLSelfRegister),,5/31/98 4:00:00
AM,22288,4.71.1460.1
File3=@STDOLE2.TLB,$(WinSysPathSysFile),$(TLBRegister),,6/3/99 4:00:00 AM,17920,2.40.4275.1
File4=@ASYCFILT.DLL,$(WinSysPathSysFile),,,3/8/99 4:00:00 AM,147728,2.40.4275.1
File5=@OLEPRO32.DLL,$(WinSysPathSysFile),$(DLLSelfRegister),,3/8/99 4:00:00
AM,164112,5.0.4275.1
File6=@OLEAUT32.DLL,$(WinSysPathSysFile),$(DLLSelfRegister),,4/12/00 4:00:00
AM,598288,2.40.4275.1
File7=@msvbvm60.dll,$(WinSysPathSysFile),$(DLLSelfRegister),,2/23/04 4:00:00
AM,1386496,6.0.97.82
```

Do not make any changes to the **[Bootstrap]** area at the very start of the file. You will do your work in the second section that is labeled **[Bootstrap Files]**. Note that the **[Bootstrap Files]** is just a specially formatted listing of the seven runtime files discussed at the start of this appendix.

With **SETUP.LST** open in **NotePad**, simply delete the lines that contain the file names that are giving you trouble. Do not do anything else. Save **SETUP.LST** and exit **NotePad**. If you think that you made a mistake, just exit **NotePad** without saving or paste the entire [Bootstrap Files] section from above into your **SETUP.LST** file in **NotePad** and then start over.

Using the **SETUP.LST** file that you modified in **NotePad**, try rerunning **setup.exe** as described in Section 2.2. If you get any error messages during this second installation, they should refer to another of the seven runtime files. Just repeat the procedure outlined above.

After one or more modifications to **SETUP.LST**, you should find that Gleams-Driver will install normally.

Whether or not Gleams-Driver will work properly is another question. Gleams-Driver is a new program and there has not been extensive experience with the application of the procedure described in this appendix. As noted in the main body of the documentation, however, a major effort has been made to avoid the use of *exotic* controls and commands that require an extensive number of DLLs. The procedure described in this appendix has worked for some individuals in the Forest Service and these individuals have not reported any problems in running Gleams-Driver. Nonetheless, on some PC's that do not have full installations of MS Office Programs and/or programming tools, a light installation may result in a successful installation but Gleams-Driver may fail, generating a runtime error, when you go to run Gleams-Driver.

The nature of the runtime errors may be highly variable depending on the configuration of your PC. For example, you may get an error indicating that COMDLG32.DLL is not properly registered. This is a dll for displaying a file selection box that is common in many Windows programs and is used by Gleams-Driver. Other errors may be much more cryptic. For example, running Gleams-Driver after a Light Installation can generate **Runtime Error -2147024770** without any further explanation. This indicates that MDAC (Microsoft Data Access Components) Version 2.8 or higher is either missing from your PC or is corrupt. This can be addressed by going to www.microsoft.com and downloading and installing MDAC 2.8 or higher. Alternatively, you can do a full installation of Gleams-Driver and this will be done by the full installation package.

Appendix 1: Troubleshooting a Light Installation *(continued)*

The above is not an exhaustive list of the things that go wrong on some PC's after a light installation. To assist you (or your IT support), the following is a list of DLLs and related files that are included in a full installation but NOT included in a light installation:

COMDLG32.OCX
MDAC_TYP.EXE
MSADODC.OCX
msadox.dll
MSDATGRD.OCX
MSSTDFMT.DLL
MSVCRT.DLL
RICHED32.DLL
RICHTXC32.OCX
scrrun.dll

All of the above files concern either standard tools (dialog boxes or rich text edit boxes), Microsoft ADO databases, or Microsoft scripting libraries. None of these files are exotic and none will harm your PC. Nonetheless, if you are working with a government PC, you may not be able to install these files – i.e., do a full installation – without administrative authorization. If you try a light installation and you get error messages, they will probably relate to one or more of the above files and you will need either the administration authority to do a full installation or direct support from your IT department.

Appendix 2: Value Codes and Descriptions for preparing text files for new chemicals

Name	**ValueCode**	Description of **ValueCode**
Description	**Desc**	This is the fully descriptive name of the chemical. It should indicate the name of the chemical and information on the run – i.e., "Hexazinone for Run of ....". This approach is taken because some of the properties such as soil halftime may differ from site to site. This field is a "Primary Key". It must be a unique name that is not already in the database.
Chemical name	**Name**	The common name of the chemical.
Name of chemical used in GLEAMS run	**PSTNAM**	Short name (up to 16 characters) used in GLEAMS files.
Number of metabolites	**NumMetabs**	Number of metabolites that are modelled in this run. For each metabolite, a full set of chemical records must be in the database.

Appendix 2: Value Codes and Descriptions for preparing text files for new chemicals *(continued)*.

Name	**ValueCode**	Description of **ValueCode**
Water solubility	**H2OSOL**	Water solubility in mg/L
Foliar halftime	**HAFLIF**	Foliar halftime in days
Koc	**KOC**	Partitioning coefficient, ratio of the concentration of the pesticide on organic carbon in soil to concentration of the pesticide in water.
Foliar washoff fraction	**WSHFRC**	Fraction of pesticide on the foliage available for washoff by rainfall.

Appendix 2: Value Codes and Descriptions for preparing text files for new chemicals *(continued)*.

Name	**ValueCode**	Description of **ValueCode**
Coefficient of transformation	**COFTRN**	Pesticide concentrations simulated in GLEAMS are mass per volume, or weight per weight (ug/L or ug/kg) and not molar concentrations. Therefore, if significant changes in molecular weight occurs from parent to metabolite or from metabolite to metabolite, the ratio of mass change can be reflected in COFTRN, also (GLEAMS documentation, p. 110).
Coefficient of uptake	**COFUP**	Consider uptake by plant (COFUP = 1) or assume no uptake (COFUP = 0). For soluble, low KOC pesticides, uptake can be significant and will reduce amounts potentially leached below the root zone. For pesticides with large KOC, little uptake in the transpiration stream will be simulated because of the reduced concentrations in solution, even with COFUP = 1.
Soil halftime(s)	**SOLIF(I)**	A pipe (|) delimited set of halftime, one for each soil horizon that is modeled – e.g., 90 | 120 | 180 | 240. These can be used in Monte Carlo analysis.
Water halftime	**WatHT**	Halftime in water in days. Can consider routes of degradation – i.e., hydrolysis, photolysis, and biological. Should not consider dissipation.

Appendix 2: Value Codes and Descriptions for preparing text files for new chemicals *(continued)*.

Name	**ValueCode**	Description of **ValueCode**
Sediment halftime	**SedHT**	Halftime in aquatic sediment in days. This should reflext all routes of degradation (photolysis, hydrolysis, volatilization, biodegradation etc.) but should not consider dissipation. Use aerobic or anaerobic data depending on the site and conditions (e.g., depth of soil layer).
Sediment partition coefficient	**SedKd**	Partition coefficient for sediment. This is used only in GLEAMS postprocessing.

Appendix 3: Notes on Volcanic and Organic Soils – Prepared by Dr. Walter Knisel

The specific values used as defaults for organic and volcanic soils is given in Table 2. This appendix discusses details concerning these soils that were considered in developing these default values.

Organic Soils

Organic soils, as the name implies, refers generally to a group of soils with high organic matter. The USDA (1975) describe *organic soils* as having organic matter content greater than 20%. They designate organic soils depending upon the degree of decomposition of the organic matter in a saturated environment – i.e., fibric (least decomposed with identifiable and distinct plant material), hemic (moderately decomposed with indistinct plant material), and sapric (most decomposed with no identifiable plant remains).

The term *peat* or more properly *peat soil* is often used to generally designate organic soils. Bersch (1907) described three types of peat as (1) sphagnum, (2) transition bog, and (3) grass peat with carbon content ranging from 100 % for sphagnum to a low of 80 % carbon for carex peat. KцhЏri (1987) described mull soils as having organic matter content between 20% and 40% and peat soils as having organic matter content >40%.

Urvas et al. (1980) described two types of peat – i.e., carex (sedge) and sphagnum. Some organic soils classed as ***muck*** have 60-90% OM in the surface and no mineral soil. The muck in areas such as Florida is a powdery black material when dry, similar to powdered carbon. Conversely, true peat is almost like undecomposed material. Thus, peat and muck have somewhat different characteristics.

Muck is defined in the Glossary of "Soil Survey, Okeechobee County, Florida", 2003, as: "Dark, finely divided, well decomposed organic soil material" and further referred to "Sapric soil material", also in the glossary, defined as follows: "The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

The fraction of clay in muck and peat soils is generally <1%. GLEAMS was developed for mineral soils, i.e. consisting of significant fractions of sand, silt, and clay. Input into GLEAMS consists of fractions of clay and silt. The fraction of sand is calculated in the model as [sand = 100 - silt - clay]. Organic matter is generally expressed as a percentage of the soil mass over and beyond the 100% mineral soil.

Organic matter is detached and transported with the clay fraction in the soil. Therefore, the fraction of clay should be entered as 100% to more nearly represent the true erosion-transport-deposition of muck and peat. Organic matter content of the surface soil horizon is used internally with sand, silt, and clay to estimate the size and specific gravity of small and large aggregates for detachment and transport.

The standard determination of organic carbon from organic matter (as in GLEAMS) is:

$$OC = OM \times 0.58$$

Shih et al. (1978) examined peat soils in Florida and found that organic matter content decreased with depth from 87% at the surface to 82% at lower depths. They further reported bulk densities ranging from 0.15 - 0.3 g/cm^3. Porosity can be calculated as:

$$POR = 1 - (BD / 2.65)$$

where 2.65 is the average specific gravity of mineral sand, silt, and clay.

Heiskanen (1994) found the bulk density of 0.13 for sphagnum peat used for forest nursery seedlings. This would be equivalent to POR = 0.95.

Appendix 3: Notes on Volcanic and Organic Soils *(continued)*

Pųivųnen (1973) determined physical and water retention characteristics of some peat soils in Finland. He found that porosity ranged from 0.70 - 0.90 cm^3/cm^3, organic matter content (OM) ranged from 55 - 84%, field capacity (FC) ranged from 0.62 - 0.87 cm/cm, and wilting point (WP) ranged from 0.20 - 0.28 cm/cm.

None of the above discussion and descriptions give any consideration to the mineral fraction of the soil. There was some reference to a relatively high clay content in organic soils. This is probably due to the fact that movement of detached sediment in runoff on flat slopes results in transport capacity mainly for fine (clay and silt) particles into basins where peat is formed.

Nash (1980) discussed organic carbon content of soils as being a necessary ingredient for microbial activity. High organic carbon, as in peat soils, would indicate a higher degradation rate of pesticides (shorter half-life) than for mineral soils such as sands. However, Leonard et al. (1987) stated that as organic carbon content of soils increased, adsorptivity of pesticides increased and apparent half-life increased. Therefore, the net effect of increased energy source and increased adsorptivity in peat soils is that pesticides are less likely to move in peat soils.

In dealing with organic soils, it should be noted that the mineral fraction of soil (sand, silt, and clay fractions) should add up to 1, but that OM is expressed as a % of the mineral fraction, meaning that the sum of sand + silt + clay + OM can add up to more than 100%.

Volcanic Soils

Volcanic soils are not as fully characterized in the literature as organic soils and the summary presented here is taken from Ping et al. (1988), NRCS/Hawaii, and a few other peripheral sources.

Lava flow/ash generally contains significant materials similar to parent material of clay. One constituent is a glass-like material. These soils generally weather to soil materials that contain considerable clay but they also have a significant fraction of sand-like non-quartz material and may have a different specific gravity. These factors do not present any serious problems in GLEAMS. The clay minerals in pumice-derived soil generally is kaolinitic rather than the expanding lattice (high shrink/swell capacity) of montmorillonite and bidellite. The surface soils in Hawaii, for example, are classed as silt loam and silty clay loam which indicates they have more silt- and clay-size fractions than sand-fractions.

References to Appendix 3

Bersch, W. 1907. Moore Oesterreich. Eine Botanisch-chem. Studie. *Ztsch. fÈr Moorkultur und Torfverwert.* 5:65, 175 195, 343.

Heiskanen, J. 1994. Hydrological properties of peat-based growth media. The Finnish Forest Research Institute, Suonenjoki, Finland. Research Paper 524. Pp. 1-41.

KųhŲri, J., V. Mųntylahti, and M. Rannikko. 1987. Suomen peltojen viljavuus 1981-1985. Viljavuuspalvelu Oy. Helsinki. 105 pp (Summary: Soil fertility of Finnish cultivated soils 1981-1985.)

Leonard, R.A., W.G. Knisel, and D.A. Still. 1987. GLEAMS: Groundwater Loading Effects of Agricultural Management Systems. Transactions of the Amer. Soc. of Agric. Engrs. 30(5):1403-1418.

Nash, R.G. 1980. Dissipation rate of pesticides from soils. In: W.G. Knisel (Ed.) CREAMS: A field scale model for Chemicals, Runoff, and Erosion from Agricultural Management Systems. U.S. Dept. of Agri.. Sci. And Edu. Admin., Conservation Research Report No. 26. pp. 560-594.

Natural Resources Conservation Service, Hawaii. Chemical and Physical data of selected soils.

Ping CL; Shoji S; Ito T. 1988. Properties and classification of 3 volcanic ash-derived pedons from Aleutian Islands and Alaska Peninsula, Alaska. Soil Science Society of America Journal, 52:455-462.

Pųivųnen, J. 1973. Hydraulic conductivity and water retention in peat soils. Acta Forestalia Fennica, 129:1-70.

Shih, S.F., J.W. Mishoe, J.W. Jones, and D.L. Myhre. 1978. Modeling the subsidence of Everglades organic soil. Trans. Of the Amer. Soc. Of Agric. Engrs., 21(4):1151-1156.

Urvas, L. 1980. Fertility of different mire type groups. Annuals of Agricultural Fennica, 19:85-91.

U.S. Dept. of Agric., Soil Conservation Service, Soil Survey Staff. 1975. Soil Taxonomy: A basic system of soil classification for making and interpreting soil surveys. USDA Agric. Handbook No 436. USGPO, Washington, D.C. 754 pp.

Appendix 4: Sample of Quick Run Save File

```
Save of Quick Run Screen
    Gleams-Driver Version1.8.184
    July 2007  12:00 AM

   You can add notes to this file but add the notes only as new
      new lines.  If you edit the existing label lines - i.e., those
      that have a label followed by a colon (:) - the file may not
      reload correctly.  You can edit the values (items on the right
      side of the label colon) but do this only if you are sure of
      what you are doing.  It is best not to edit this file directly.
      A better approach is to reload this file into the Quick Run
      Screen, make the changes that you want, and then resave the file.

GENERAL INFORMATION
                  Driver File:C:\W\Gleams-Driver\Version
1.1\Program\Examples\TestRun\TestRun.mdb
              Simulation Name:TestRun Output
     No. of Weather-Year Sets:5
          Repetitions Per Set:1
                  Random Seed:
          Weather Year Offset: 3

TREATED SITE
                 Type of Site:Mixed pine-hardwood forest
                     Location:Badlands NP, SD
                Surface Cover:No surface depressions
                 Surface Type:Meadow
             Runoff Potential:Moderate
            Surface Condition:NOS
       Treated Field Area(ac):10
         Total Field Area(ac):10
                  Field Width:660
                        Slope:0.1

SOILS
          Depth of Route Zone:60
                 Cover Factor:0.15
                 Type of Clay:Mixed
     Default Soil Variability:False
-------------------------------------------------------------------------
Soil Layers                    Soil Texture              |   Depth (in.)
-------------------------------------------------------------------------
                 Soil Layer 1:Coarse sand                |            60
```

Appendix 4: Example of Quick Run Save *(continued)*

```
APPLICATION INFORMATION
                     Chemical:2,4-D/clay, Std
                        Month:June
                          Day: 15
                Starting Year: 2007
                  Ending Year: 2008
           Application Method:Surface Application
      Application Rate (lb/A):1
             Prop. to Foliage:0.5
                Prop. to Soil:0.5
       Depth of Incorporation:1
    Default Appl. Variability:False

NONTARGET SITE
              Field Size (ac):10
          Prop. lost to field:1.0
           Dissipation Option:Based on GLEAMS

INFORMATION ON WATER BODY
    For convenience, all lotic bodies of water are referred to as 'Streams'
       and all lentic bodies of water are referred to as 'Ponds'.
           Type of Water Body:Pond (or other lentic type)
    Fractional Drift to Water:
       Percolation Proportion:1.0
       Consider Water Balance:True
   Default WB Gen Variability:False
 Default WB Drift Variability:False
         Surface Area of Pond:1
        Initial Depth of Pond:2
       Sediment Depth in Pond:2
        Minimum Depth of Pond:1
        Maximum Depth of Pond:3

RUN OPTIONS
                Save All Data:True
```

Appendix 5: Revision Summary

Version 1.0 of Gleams-Driver was developed under USDA Forest Service BPA: WO-01-3187-0150, USDA Order No. AG-43ZP-P-05-0037. Gleams-Driver is currently under review and various modifications have been made to the program. The current document is an interim update to the Version 1.0 User's Guide (SERA TR 06-43-28-01d, dated May 26, 2006) to reflect the changes that have been made up to and including Version 1.8.

Version 1.0 – May 22, 2006

May 22, 2006 – Version 1.0 Release, SERA TR 06-43-28-01b
In the beta-version, input and output were based on the automation of MS Word. Substantial problems were encountered in the portability of the program on different operating systems using different versions of MS Office. For the release of Version 1.0, the use of MS Word has been removed. Both input and output are now based on MS Access databases. The MS Access computer program, which is part of MS Office, does not need to be installed to use this program. The necessary MS Access drivers are automatically installed with the program is a full installation is done. See Section 2.2 for details of a full and light installation.

Other minor changes to the program include some additional help screens for new users and a check for screen resolution that is made when the program is first run on a machine.

May 23, 2006 – Version 1.0.92, Package 1, SERA TR 06-43-28-01c
Various typos and holdover references to MS Word have been deleted.

May 26, 2006 – Version 1.0.98, Package 2, SERA TR 06-43-28-01d
The Delete feature of the Edit window in the Full Run did not work correctly in the initial release. This has been corrected. Also corrected minor typos in documentation.

Version 1.1 – January 14, 2007

January 14, 2007 – Released Version 1.1 with expanded databases for locations and chemicals and a revised database for soils.

Version 1.2 – February 1, 2007

Released Version 1.2 which incorporated a standard windows help system. Removed Quick Help utility. Dropped support for Light Installations.

February 16, 2007
Had to re-institute support for light installation because of installation issues involving administrative privileges on some Forest Service PCs.

Version 1.3 - March 17, 2007

Revised documentation for Version 1.3. Corrected a minor bug in the Quick Run screen in which the End Year was not correctly use to set the run times. Corrected a major bug in which the Gleams-Driver program did not properly check the inputs for constraints that are required by GLEAMS. Added a number of enhancements, primarily to interface and capabilities of the Quick Run. Released the Version 1.3 documentation which encompasses enhances made to Versions 1.1 and 1.2, both of which were released without a revision to the documentation.

Version 1.4 - May 7, 2007

Release of Version 1.4 with revised documentation. Enhancements and bug fixes include the following:

Two organic soils (peak and muck) as well as volcanic pumice have been added to the soils database and these are available from the Quick Run screen. In addition, a Utility has been added to allow the user to examine and edit the soils database and to add or remove soils from the soil database. All changes made by the user will be in effect when the Quick Run Screen is reopened. The new soils are discussed in Appendix 3 of the documentation.

In Section 4.6 of the documentation, the discussion of the pond and stream models has been expanded based on feedback from and discussions with Forest Service personnel. Three subsections have been added: pond, stream, and the impact of the untreated field.

In the Quick Run, water balance for a stream was not considered even if the water balance box was check. This has been corrected.

The output Access database now contains a complete copy of all of the information (data tables) in the input Access file.

A special note on spot applications has been added to the documentation. In addition, the Quick Run screen also contains a special information button on spot applications that brings up the appropriate help screen.

The program will now just skip a non-weather file in the \SupportFiles\Locations subdirectory. In previous versions, an error message was generated and the user could not do a run. This restriction was not necessary.

The program can now import files from either Cligen Version 4.3 or 5.2.

The Cligen import utility has been expanded to allow the user to adjust the Cligen output. This feather is detailed in Section 6.1.1 of the documentation.

When selecting the Cligen input file, the file selection utility will now look for files with a *.cli extension by default. Cligen files, by default, are created with *.cli extensions.

In previous versions, attempting to do a second Quick Run from the Quick Run screen after the initial Quick Run was completed would cause a runtime error. This has been corrected.

In previous versions, attempting to set drift to zero would cause a runtime error. This has been corrected. Zero drift is now the default.

In previous versions, the program to always saved the input files for GLEAMS regardless of the settings in the driver file. This has been corrected.

In Version 1.3, all "Use Default Variability" boxes were checked by default. In Version 1.4, all "Use Default Variability" boxes are unchecked by default. An addition "Use Default Variability for All" box has been added to the bottom of the Quick Run Screen. A discussion on the merits of using default variability has been added to Section 4.7 of the documentation.

In a Quick Run, H2OSol and COFTRN had been given distributions in Version 1.3. Both of these are treated as constants in Version 1.4 even if the "Use Default Variability" box is checked..

Some labels on the Quick Run Screen has not properly displayed in Version 1.3. This has been corrected.

Included the April 2007 maintenance release of GLEAMS 3.0 from the USDA/ARS web site.

Version 1.5 July 30, 2007

Release of Version 1.5 with revised documentation.

General Changes

The following GLEAMS outputs are now added to the output for each site:

	Codes
Pesticide concentration in runoff (mg/L)	**11001-11366**
Pesticide concentration in sediment (µg/g)	**13001-13366**
Pesticide concentration in percolation below the root zone (mg/L)	**15001-15366**

For a stream, the field "Total Flow" has been added to the output . In previous versions this had to be calculated from base flow and added flow. This is done to make the EXCEL reporting utility easier to handle.

Corrected a trivial but important bug in a function for getting a Julian Date in which the current date rather than the date being passed over to the function was being used. This caused the program to crash if the user picked a start year that was different from the current year.

Corrected a very nasty bug in which the effective application rate for the nontarget field was not written to the summary statistics screen at the end of a Quick Run and was not written to the output text file even though the data for the nontarget field was in the Statistics database created by Gleams-Driver.

Changes to Quick Run
The Quick Run screen can now be saved as a text file and re-loaded by the Quick Run screen at a later time. You cannot, however, load an Access Input database into a Quick Run Screen. This is discussed further in the revised documentation (Section 4.7)

In a Quick Run When a steam is selected, the sediment depth text box is no longer visible. Sediment depth is not currently implemented for a stream.

In previous versions, the year could not be less than 2000. The start year can now be any year starting at 1900. This change is made as a convenience for doing retrospective modeling to assess the plausibility of model outputs – i.e., you can now enter the year when a prior application was made in the twentieth century.

In the nontarget field area of the Quick Run form, the label for the fixed field dissipation rate on the Quick Run form (which is only visible when the user selects the "Use fixed rate" option) had indicated units of "Days". This was an error. The dissipation rate must be in units of $Days^{-1}$. This has been corrected.

Changes in labels of Quick Run Screen: In the upper part of the screen (General Information), the "Simulation Name" label is changed to "Output File Name" label which is more descriptive. In the bottom part of the screen (Run Status), the option previously labeled "Save Intermediate Data" has been changed to "Save All Daily Data", which is more descriptive of what is being done.

In the Quick Run screen, selecting either soil injection or soil incorporation will reset the proportions of the pesticide applied to soil and vegetation to 0.99 and 0.01, respectively. This will only occur, however, if the default values of 0.5 and 0.5 for surface application and chemigation are in the two fields for proportions. Similarly, selecting either surface application or chemigation will reset the proportions of the pesticide applied to soil and vegetation to 0.5 if the default values for soil injection or soil incorporation are in the proportion fields. Any time the values for proportions are automatically changed by the program, the user is notified with a beep and a note is displayed in the "Tip" window.

Full Run
In the full run edit window for the data tables in the driver database, the irritating tool tip that appeared over and obscured the fields that the user was attempting to edit is now gone.

An anomaly in which changes to the last record in a data table were not being saved when the user switched to a different data table has been corrected.

Version 1.6 - September 8, 2007

Release of Version 1.6 with revised documentation. The summary of revisions is moved from the front matter to Appendix 5.

Quick Run

The Water Body section of the Quick Run screen has been resigned to incorporation reservoirs – i.e., non-instantaneous transport of water and pesticide from percolate, runoff, and sediment to the body of water. See Section 4.6.4 of this revised documentation.

Other minor changes include the additions of constraints to CN2 and a modification to the algorithm for calculating the Weather Offset in the Quick Run Screen. In addition, the default variability has been changed from a triangular distribution that was bounded by half to twice the mode to a triangular distribution that is bounded by 90% to 110% of the mode. The distributions can be reset but only using the Full Run utility.

Full Run

The Access input table for the Site – i.e., the treated field – now includes a option (value code = FLGPEN) to specify the algorithm for evapotranspiration. A value of zero will direct GLEAMS to use the Priestly-Taylor algorithm for ET and a value of one will direct GLEAMS to use the Penman-Monteith algorithm. In previous versions of Gleams-Driver, only the Priestly-Taylor algorithm was implemented.

Known Issues in Version 1.6

NETWORK SERVERS: Some Forest Service employees have gotten errors on a network server when they tried to save output files to the network server. Selecting a location for the output files on the users hard drive worked. This is not something that can be generally addressed with modifications to Gleams-Driver. The problem is related to security issues on the server.

Full Runs: When site or water bodies are deleted using the full run facility, the program may generate a runtime error. This problem seems to be intermittent and the cause (and hence the solution) has not yet been identified.

Version 1.7 – October 21, 2007

Release of Version 1.7 with revised documentation.

General

A bug has been corrected in which the input for Drift was not copied to the Application table in the output database if the value for Drift was blank. This bug had no impact on the results but it did generate a confusing error message.

The Quick Run Screen in Gleams-Driver has always displayed a warning message if the user tries to model a treated field that has an area greater than 1 square mile. An elaboration of this cautionary note has been added to Section 4.2 (Quick Run, Application Site) indicating that GLEAMS is a field-scale model that may not be appropriate for attempts to model large water basins.

Quick Run

Multiple applications per year can now be specified. If more than one application is specified, the user can enter an application interval. The first application will occur on the start date specified in the Quick Run. All subsequent applications will occur on dates derived from the application interval. In addition, the *application cycle* can be varied. In previous versions of Gleams-Driver, all applications were repeated in each year of the simulation. See Section 4.4 for details.

Three chemicals have been added to the soils database: hexazinone, carbaryl, and malathion. Hexazinone had been inadvertently omitted from the Version 1.1 release. The carbaryl and malathion entries are based on the peer review drafts for the Forest Service risk assessments on these insecticides that are currently in preparation.

The Quick Run screen no longer closes if the user hits the Run Button (making the input file) and then decides not to do the run. This makes it easier to set up input files for a number of related runs. In addition, the output file name will automatically be renamed as XXXX Output whenever the driver file name is changed.

Full Run
A section has been added to the Full Run documentation (Section 5.6) that recommends and describes web resources that may be useful in development of full runs.

Series Driver
A Series Driver button is added to the main window. This allows you to do multiple Gleams-Driver runs from a directory that contains multiple driver files. The use of this new feather is discussed in Section 3.2 of the documentation.

Other Utilities
In the course of developing and testing Gleams-Driver, several M.S. Office utilities have been developed. These have been released for general use with Gleams-Driver Version 1.7 and are discussed in Section 8.5 of the revised documentation (M.S. Office Utilities for Using and Documenting Gleams-Driver Results).

Version 1.8 – December 31, 2007

Release of Version 1.8 with revised documentation.

The error reporting features of Gleams-Driver have been redesigned to accommodate the Series Run capability that had been introduced in Version 1.7. As detailed in Section 8.1 of the documentation, each time that a simulation is started, however, errors are redirected to a run-specific error file. Thus, if a Series Run is being done, multiple error files are generated, each specific to a single run.

In addition, the error system has been redesigned so that a Run Error Report form is automatically displayed if any internal errors or warning messages are generated during a Quick Run or Full Run. In previous versions, errors had been recorded to the error file but the user was not notified that errors had occurred – i.e., it was up to the user to check the error file. Now, the user is either notified that no errors occurred or is notified that errors occurred and copies of the error file are displayed on screen.

Version 1.7 had a bug in which a false error message was generated when using the options in the utility to modify Cligen files. This has been corrected. In addition, the Cligen import utility did not properly consider temperatures that were below zero when the user had specified an adjustment factor. The adjustment factors are multiplicative. Thus, in the previous version, a factor of 1.05 would increase the temperature by 5% and 0.95 would decrease the temperature by 5% but only if the temperature was above zero. If the temperature is negative (below zero), the reverse is now done – i.e., the temperature is divided by the factor rather than multiplied.

The internal constraint on the upper bound of saturated conductivity in the root zone (SATK) has been increased from 0.75 in/hr to 5 in/hr. The constraint on the upper bound of saturated conductivity in the restrictive layer below the root zone (RC) is unchanged (0.75 in/hr). In general, RC will not approach 0.75 in/hr but SATK could be greater than 0.75 in/hr.

In specifying distributions for a Full Run, previous versions of Gleams-Driver would accept **`LogNormal()`** to specify a lognormal distribution but would not accept **`Lognormal()`**. **`Lognormal()`** is a more intuitive use of capitalization. In Version 1.8, both forms are accepted.

Appendix 5: Revision Summary*(continued)*

The documentation has been modified based on review by Dr. Walt Knissel. In addition, the documentation reflects the changes to the modified error reporting features. The Help utility has also been updates. In Version 1.7, the Help Utility did not include any help information for the Series Run. This has been corrected.

Lastly, some of the MS Office utilities (Section 8.5 of the documentation) have been updated. The CommonDialog Control, which had generated runtime errors on some PCs, has been replaced with an instance of the FileDialog Class. This is simply a change in programming technique. The user interfaces are unchanged.